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Science Education

THE FUNCTION OF SCIENCE IN DEMOCRACY *

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The attention of the nation is today directed toward the defense of democratic society. The immediate aspect of our present way of life is war and the necessity of winning that war in order that we may continue to live in peace according to the pattern established by our forefathers. And unless we win the war it is likely that we will not have a democratic society to defend. Our most important job today as individuals is relatively simple. It is to give our best efforts to our own particular jobs. Nevertheless, while we are concentrating on our jobs we must remember that no matter how important the issues of the present emergency may be, there is an even more important problem facing us in the defense of democracy. It is the problem of developing a citizenry, a free people, capable of attacking and solving the problems of reconstruction after the emergency of war is over. This consists of training all free men in the processes of clear thinking according to the pattern that is fundamental to science and the scientist.

Involved in this problem are all the issues attendant upon the education of free men which throughout all history has been a most difficult undertaking. At present the swing is away from democracy toward despotism and all our best efforts must be devoted to the struggle for educating men to keep them free.

For thousands of years men have struggled against tyranny and oppression toward freedom and liberty. Science has made significant contributions to this freedom from tyranny although despots have shaped scientific achievements to their own ends. Today they make slaves of men who work with power machines just as despots of old made slaves of men who worked with their muscles.

For men to be free and happy, certain material wants must be satisfied. Food, clothing, shelter, and a sense of security are necessary. Men have always hoped for better material conditions of living and science has made it possible for men of today to enjoy material comforts. In a despotism, however, men are of no importance, consequently the advances of science are directed towards war to keep the people in line.

Doge Thomas Moncenigo in Venice in 1421 observed that: "All you need to do to maintain our happy state of affairs is to pray God to keep you in the healthy track you have followed to this day. If you keep on, you will become powerful and possessors of all the riches of the Christian world. Guard against taking other people's goods as you would against fire; and against making war unjustly. If you do, God will punish you for it. Then those who now have 10,000 ducats will have 1,000; those who have ten houses will be reduced to one; and so on with everything else. No more goods; no more credit; no more reputation. Instead of masters as you now are, you will find yourselves subjects, and of whom? Of these soldiers, warriors, mercenaries whom you hire."

It is only in a democracy that men are of worth. Only in a democracy can sci-

* Paper read at the meeting of the Iowa Association of Science Teachers, Des Moines, Iowa, November 7, 1941.

ence make its most significant contribution to the elimination of want and to the pursuit of happiness.

To pursue and secure happiness, to secure peace and the enjoyment of material wants, democracy must be the way of life.

That educators are aware of this problem may be readily seen in the emphasis being put upon the study of democracy in our schools. When we consider the mass of materials, articles, pamphlets, speeches, posters, movies, and books that are being produced in an attempt to direct the attention of school people to this problem, we realize not only that an enormous amount of time and money is being expended in this effort but that the task is one of the most difficult we have ever had to solve.

Educators are not alone in this endeavor. We note that the Tenth Fortune Round Table was devoted to the discussion of demobilizing the war economy and the problems likely to confront American democracy after the production of defense materials comes to an end. Economists, scientists, agriculturists, industrialists, all of top flight caliber, were participants in this forum.

I quote from two of the participants of this Forum.* Mr. George O. Curme (Union Carbide and Carbon): "There is a saying in chemical circles that it takes ten years to go from the test tube to the tank car. . . . Between five and fifteen years is a fair period for anything that is really new to develop out of the laboratory and get into volume that is even moderately important, and when we are talking about the employment of millions of men, I would say that perhaps it is going to be nearly twenty or twenty-five years before you could get something that was new, no matter how good, that would employ even a couple of hundred thousand men. The thing that is open, however, is the thing that has been fairly well known, that has already had scientific success, but that may go over in volume and become much greater in its industrial importance without, perhaps, any great addition of scientific accomplishment. Plastics is one of these items. Mr. David C. Prince (General Electric): "What is important is that the workers be engaged in making things that will better the national standard of living. The only way to get full employment after the war, in Mr. Prince's opinion, is for every company to start now to build up a bank of new products, improvements over present products, new ideas—things that can be launched as soon as the war has ended. Every division of a company should be charged with producing something new and better in its own field so as to create new jobs."

Everyone seems to be searching for the philosopher's stone that will turn each child into a competent, cooperative member of a democratic society. In general, the direction of the search is focused on the social studies and the study of current problems in economics, sociology, and political science. Content, specific techniques, and methods are being developed and suggested for use in teaching-learning situations in order that youth may gain an understanding of, a loyalty to, and a desire to participate in democratic living.

There are many who say we should forget science and further scientific development for several years, not only to have a breathing spell, but also to allow our knowledge in the social studies an opportunity to catch up with our knowledge in the natural and physical sciences. Similarly, there are some who say break up the New York Yankees baseball team, or break up the Chicago Bears football team. Seriously though, would we consider it necessary to destroy our Corots, Beethovens, Bachs, Newtons, Pasteurs, Einsteins, Oslers until all the plodders in other fields have caught up or acquired the spark of creative endeavor? You do not raise the

* The Tenth Fortune Round Table on Demobilizing the War Economy, Berkshire County, Mass., September, 1941.

general level simply by destroying creative ability nor by holding back the leaders. One aspect of a democracy is overlooked by those who make such a statement, namely that of the ideal of respect for and the appreciation of talent, training, character, and excellence in all fields of socially useful endeavor.

The problems of democracy are those concerned with human relationships, yet, for the most part, the causes underlying these problems are things. In the past we have directed more of our attention to things than to men in our endeavor to achieve security and a better way of life. Science has had a great deal to do with the development of modern society and all its related problems in human relationships; consequently, we might well ask what it has to offer in providing solutions.

But, you say, the methods of science are essentially methods of discovering order in natural phenomena. It is the ultimate aim of science to discover order in nature, not in human affairs; yet, to discover order in any group of phenomena is to explain the phenomena. The most common explanation is that given in terms of laws, the overturned automobile in terms of Newton's laws, the hydraulic brake in terms of Pascal's law, the sinking ship in terms of Archimedes' principle. In the explanation of human behavior, however, we must include the motives or purposes governing the behavior. Modern science attempts merely to describe phenomena, yet, if modern science is to serve us in our study of human behavior and human relationships as an aspect of the education of free men for democratic living, then it must be concerned with motives and purposes, and the development of order in human affairs.

When we begin to consider the problems of the modern world and its changing aspects, there are those who would scrap all the old and start anew. Yet, we must remember, with Thorndike, that no matter how great the change, the new world must be based upon what we know from the past about our art, architecture, sculpture, medicine, and engineering. The new can only be built upon the old. Changes are always based upon things which are changeless. The development of modern science is based upon fundamental principles of nature that are changeless although our expression of these principles may change from time to time as more knowledge is accumulated.

Most of the present problems of human relationships have developed as the outgrowth of the scientific discoveries and inventions of man in his struggle to come to grips with his environment. As one man came to grips with his environment he built an automobile which could be produced in such large numbers that everyone could own one. Probably no single invention has had such marked influence on the changes which have occurred during the past thirty years as has the creation of the automobile.

People with automobiles had to have roads, so roads were built. The building of such roads had to be financed so state and nation divided the expense. People on roads had to have services; gas, oil, water, food, and shelter, as well as destinations; so gas stations, motor inns, garages, tourist camps, hot dog stands, summer camps, and national parks developed as a part of our new environment. When people spend a considerable amount of their time away from home, they do not need houses that are large, so houses become smaller. Houses were placed out near the edge of the cities because men could live farther from their work. Living farther away from the center of the cities necessitated an expansion of public utilities and all other services. Cars could be made more quickly by mass production. Men could work faster for fewer hours. More hours were available for recreation; thus, movies, radios, ball parks, golf links, and swimming pools developed. All of these: radios, movies, electric refrigerators, and other gadgets wrought changes in our

mode of life. We have more and longer week end trips, more and larger chain stores, less church attendance, great buses and trucks speeding over our highways, mechanized divisions in our army, great commercial and military airplanes soaring through the sky, labor unions with all their attendant problems, social security, crop controlled agriculture, these and hundreds more. All of these changes wrought by science have caused fundamental changes in our social, economic, and political structure. The result is that we are today faced with complex domestic problems from within that are difficult of solution and which require all our best efforts, yet we have in addition a war to face from without.

The time is ripe for someone to point the way to the solution of our problems of human living. Why shouldn't it be the scientist? There is no panacea, no philosopher's stone, no superman who knows the answer, yet the lessons of science and scientific method contain some of the fundamental principles which might be turned to most effective use in a democracy. Science, itself, is neutral, and will work for despotism as well as democracy. The use to which science is put depends entirely upon the intelligence and the motives of the men who control its output. The scientist may develop a product to alleviate pain, to cure disease, to purify water, to speed up transportation, to bring happiness into the world, yet society and its leaders may determine whether or not the product is to be used for the benefit of free men in the pursuit of happiness or whether it shall be used to enslave man and destroy his civilization.

In "Learning the Ways of Democracy" published by the Educational Policies Commission,* we find summarized the "Hallmarks of Democracy." As we use these hallmarks to develop an educational program designed to educate free men for democratic life, let us as teachers remember that the contribution of science teaching to an understanding of modern life is just as important as an understanding of the social studies. The percentage of enrollments in science during the past ten years does not indicate that this is true, because this percentage has been decreasing continuously, not quite so rapidly, however, as the social studies have increased. Now, do not misunderstand me, I am eager to have all people possess a clear understanding of the social studies, that is, provided they have a sound foundation in history upon which to build their structure of understanding. What I want to emphasize is this: For free men to live intelligently in a democracy such as ours, one based upon, developed by, and maintained according to scientific discovery, they must have a clear understanding of the fundamental science laws and principles and of even more importance they must understand the social implications involved in the application of these principles.

Let us consider the first hallmark of democracy as included in the Educational Policies Commission publication. It is stated, "the central purpose of democratic education is the welfare of all the people." Bear in mind the general welfare of all people. I think no one would quarrel with that purpose of a democracy. In spite of the great contributions of science to general welfare in providing abundant food, adequate shelter, a surplus of clothing, good health, and the hundreds of other contributions, there are still people hungry, undernourished, sick, and living in houses not fit for human habitation. Either they do not know about these things or they are unable to take advantage of them. Likely, it is because our best minds have not been devoting their efforts to the particular phases of the problems that would insure proper distribution of these goods. Science also has much to contribute to the general welfare in breaking down prejudice and eliminating superstition, not only through

* *Learning the Ways of Democracy.* Educational Policies Commission, National Education Association, Washington, D. C., 1940.

the work of the scientist in his research laboratory but also through the knowledge imparted by the science teacher in the classroom.

Scientific inventions and discoveries cannot make a contribution to democratic life and the education of free men unless people are able to understand, to appreciate, and to accept all that science has to offer. One of the important functions of science in a democracy is that of developing not only an understanding of but a willingness to discriminate between science and pseudoscience. Not every white jacketed clerk selling cosmetics is a scientist; not every advertisement reading "science shows it to be 87 per cent cooler"; not every vitamin "cure-all" is a product of real scientific discovery, tested and retested until no evidence to the contrary can be found, yet there are many people who think so.

The contribution of science to the general welfare of free men will include scientific discovery devoted to health, medicine, housing, and other material needs. Also science teaching will be directed towards the social, economic, and political implications of scientific laws and methods.

Consider the second hallmark, "Democratic education serves each individual with justice, seeking to provide equal educational opportunity for all, regardless of intelligence, race, religion, social status, economic conditions, or vocational plans." If we accept this as one of the hallmarks of democracy, what is there that science in a democracy can contribute to it? In a totalitarian state it can twist its facts to show that one will is superior, and administer it in such a manner that there is no justice.

If two people step out the tenth floor window of a building, one does not go up and the other go down, nature serves them exactly alike. Is it possible for us in our study of the law of gravity to develop similar concepts for actions in human behavior?

Certainly science, which has suspended judgment as one of its major tenets, should make a contribution to the third hallmark. This third hallmark is stated, "Democratic education respects the basic civil liberties in practice and clarifies their meaning through study." 'Access to' and 'a willingness to use reliable information' and 'the right to form one's own opinion after all the objective evidence is in' are certainly civil liberties that science teaching can consider in its field of endeavor.

We have had hundreds of thousands of experiments performed in our science laboratories, also we have had hundreds of experiments devoted to the study of the techniques, procedures, and outcomes of various types of laboratory teaching in science; yet, pupils come from the laboratories with a willingness, even an urge, to use unreliable information. They also have the habit of forming opinions without either the evidence or the desire to find the evidence. In fact, there are many people who seemingly make no attempt to question claims or statements, or to question rumors, especially if the words science or scientific appear in the claim or statement.

The attention of science teaching might well be directed toward the distribution of employment, of goods, and of services; to health and housing, which are conditions affecting the ability of people to enjoy liberty. These are all included in hallmark four which is stated thus, "Democratic education is concerned for the maintenance of those economic, political, and social conditions which are necessary for the enjoyment of liberty."

I recently heard T. V. Smith charge teachers with the task of discovering scientific minds, curious minds, doubting minds, skeptic minds, minds able to cope with such problems. Not all pupils have the kind of intelligence or personality which will enable them to become scientists, that is people who search for the truth. Although I agree with Dr. Smith that teachers should consider it their duty to pick out such minds, I think they must also guide the minds of all our boys and girls to a

clear understanding of the social implications of the contributions which science has made to the education of free men.

Some time ago, after listening to an expert in the Department of Agriculture extol the brains represented in that department, I asked him this question, "What is the most important problem confronting the Agriculture Department?", to which he replied, "Distribution." My next question was, "Then, with all the brains represented in the department, why isn't something done about distribution instead of expending all the efforts on production and its curtailment?" His reply was, I think, a most significant one, "We don't know anything about distribution." The selection, training, and direction of our best minds to the solutions of such problems, and the training of all minds to demand the solutions, might well be the job of science teaching. It would certainly affect the conditions governing the ability of American citizens to enjoy liberty.

The lesson of democratic discipline is to my mind the most important to which science teachers can devote their attention. It is, "Democratic education teaches through experience that every privilege entails a corresponding duty, every authority a responsibility, every responsibility an accounting to the group which granted the privilege or authority." Science education teaches, "To every action there is an equal and opposite reaction," "the amount of work accomplished is measured by the product of the force acting and the distance through which it moves," "the work expended is equal to the work accomplished," "power is the rate of doing work," "whenever energy is expended on a machine an exactly equal amount of energy always appears, either as useful work or as heat," "energy may be transformed, but it can never be created or destroyed." Do these statements imply a respect for authority, one of the tenets of democracy?

No lesson is more needed today than that of discipline, a self-directed discipline. Nature has a discipline which science teachers might well use in the educational programs designed to produce a democratic way of living. The social implications of the conservation of energy need to be stressed in our science teaching. "You can't get something for nothing," must be instilled into the thoughts and actions of every citizen, not only as it actually operates in the physics laboratory but also as it should operate on the playground, in the home, in industry, and in our governmental activities. Can science, and science teaching, and the habit of scientific thinking contribute to the accomplishment of this aim? The principle of work in equals work out must be made to operate in human affairs.

Certainly in this day of speed, a thorough knowledge and understanding of Newton's laws of motion might profitably be possessed by everyone. This knowledge if possessed by all people might not reduce the number of automobile accidents and it might not improve human relationships but certainly there are plenty of practical applications for use in illustrating the laws.

What I have tried to say is that free men must be trained to participate in the knowledge, the culture, the thought, the concepts upon which its civilization rests or it must be ready to accept the dictates of a special ruling class.

Gerald Wendt, one of our foremost interpreters of science, has recently said: *

"Does it not occur to us that science must have some secret of success? Why this stupendous achievement, this conquest of time, space and power, this seeing beyond the farthest star, this intimate knowledge of tiny bacteria and vitamins? Why in this endeavor has man been so colossally successful, when in other directions he fails and fails again? Contrast our progress in science with the pitifully small change in the content of life, in the last one thousand, two thousand, yes, three thousand years. Note how under our very eyes civilization goes backward with respect to freedom, security and brotherly love. The one great successful achievement of mankind seems to have taught us no lesson, has

* The Dinner Gong, Associated Executive Clubs, New York, October, 1941.

allowed us only to use its material products. Has it no more to teach?

"Yes and the secret is very simple. Science is successful because, first of all, it respects the facts before all else. Second, because it seeks always general laws of behavior that are revealed by the facts and bring understanding. Third, because it discards ruthlessly any theory that does not work, no matter how well it seemed to work under past conditions. Fourth, because it believes in improvement, in evolution, in progress, in change. It has its eyes on the present and future—not on memories of the past.

"And finally, it is successful because it has a profound confidence in the human mind and in its ability to create what it needs. Thus it moves ever forward, from age to age, and with no limits of national boundaries, or race, or tradition."

In conclusion, the functions of science in a democracy, in a society for free men, seem to me to be:

1. *To reveal,* to open the eyes and ears of all people to the wonders of their environment, the plant life, the animal kingdom, the phenomena of physical forces and the wonders of chemical changes.
2. *To develop understanding* of the social implications of the contributions which scientific discovery has made and should make in medicine, in health, in hygiene, in nutrition, in housing, in agriculture, in transportation, in communication, in our cities, in farm life, in home, in industry, in churches, and in habits of living.
3. *To form habits,* abilities, skills and to develop functional knowledge of science that will aid people in coming to grips with their environment both as producers and consumers.
4. *To instill* the pattern of scientific thinking into well disciplined minds and to direct the application of this thinking into every area of human endeavor, social, economic, and political, that we may have solutions to many current problems.
5. *To teach* the lessons of nature's discipline as a basis for democratic discipline. From the laws and principles of nature, we might well develop a philosophy of action for operation in human relationships. The respect for authority and the work of the expert is fundamental to the operation of democratic society.
6. *To create* new ideas, new products, new inventions and thus create new jobs as a basis for continuing the democratic way of life.
7. *To contribute* to the general welfare of all free men, a positive, wholesome, constructive, and abundant life for all.

A DETERMINATION OF THE RELATIVE IMPORTANCE OF PRINCIPLES OF PHYSICAL SCIENCE FOR GENERAL EDUCATION—II *

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Table IV presents data which show the distribution (as new or duplicate) of the assignments given the applications resulting from the analysis of each of the eleven sources.

TABLE IV

DISTRIBUTION OF ASSIGNMENTS OF APPLICATIONS FROM EACH OF THE ELEVEN SOURCES

	A	B	C	D	E	F
Book	Number of Applications Resulting from Analysis	Number of Assignments of Applications to Principles	Number New Assignments	Number Duplicate Assignments	Per Cent of New Assignments	Per cent of Duplicate Assignments
1	440	657	657	0	100	0
2	408	774	517	257	67	33
3	354	664	600	64	90	10
4	269	588	106	482	18	82
5	316	564	240	324	43	57
6	349	746	307	439	41	59
7	474	900	384	516	43	57
8	212	450	162	288	36	64
9	478	869	259	610	30	70
10	421	837	50	797	5	95
11	405	875	131	744	15	85
Total	4126	7924	3403	4521		

This table should be interpreted as follows: Book No. 2, yielded 408 applications which were given 774 assignments to principles. Of these 774 assignments, 517 were new to the lists of applications already assigned from Book No. 1, while 257 duplicated assignments resulting from Book No. 1. Thus 67 per cent of the assignments from this source were new to the lists and 33 per cent duplicated applications assigned from the first book.

The two columns at the right of Table IV indicate a general tendency for the percentage of new assignments to decrease and the percentage of duplicate assignments to increase as the analysis and assignment proceeded from the fifth to the eleventh book. This tendency is not noted in the case of the first four books because these books were specialized textbooks of physics and chemistry, while the last seven were general or survey textbooks. Again, this tendency indicates that the addition of a greater number of sources would probably have resulted in carrying the analysis of sources and assignment of applications beyond the point justified by the reliabilities of the methods employed.

When all applications selected as a result of the analysis of the eleven sources had been assigned to principles, the entire list of principles together with the applications assigned to them was submitted to four

* *Concluded from the December, 1941, issue.*

competent, experienced teachers * of science for checking (1) the adherence of applications to the criterion of practical and cultural value, (2) the assignment of applications to principles involved in their explanation, (3) the possible duplication of applications appearing under any one principle.

Whenever three or more of these judges questioned the inclusion of an application under the criterion of practical or cultural value, that application was discarded. If the assignment of an application to a principle was challenged by three or more judges, the application was deleted from those assigned to that principle, and if it was not already defensibly assigned to some other principle or principles, it was discarded from the study. If two or more applications appearing under any one principle were considered to be duplicates by three of the judges, the application considered by the investigator to be most clearly stated was retained under the principle and those others, which, in the opinion of the judges, were duplicates of the one retained were deleted from the list of applications appearing under this principle. As a result of these procedures a total of 205 applications were deleted from the list appearing under some one of the principles to which they had originally been assigned, thirty-five were discarded from the study for failure to meet the criterion of practical or cultural value, and ten because, in the opinion of a majority of the judges, they had not been defensibly assigned to any principle of the entire list. Thus, the total number of applications assigned to all principles were reduced from 3,403 to 3,153

TABLE V

SUMMARY OF DATA OBTAINED FROM ALL SOURCES

	A	B	C	D	E	F
	Number Principles in Tentative List	No. Principles in Tentative List to Which Applications Were Assigned	Number Principles Added to List	Total Number of Principles to Which Applications Were Assigned (B+C)	Range of Number of Applications Assigned to Individual Principles †	Total Number of Applications Appearing Under All Principles †
Physics	165	155	16	171	1–98	
Chemistry	68	53	2	55	1–75	3153
Geology	19	18	2	20	2–28	
Total	252	226	20	246		

† The figures shown in these columns represent the number of applications remaining after refinement of the lists in accordance with jury opinion.

Table V presents a summary of data obtained as a result of this section of the study. It will be noted that twenty principles were added to the tentative list as a result of the appearance of applications which could not be assigned to those principles already formulated. The minimum number of applications assigned to any one principle was 1 and the maximum, 98. Applications were assigned to 246 of the 272 principles in the composite list. The total number of applications appearing under the 246 principles was 3,153. It

* Dr. F. D. Curtis, School of Education, University of Michigan; Mr. Wesley C. Darling, School of Education, University of Michigan; Mr. Mark Delzell, Teachers College, University of Nebraska; Mr. Harley F. Glidden, Osceola Junior College, Osceola, Iowa.

should be noted that this number does not represent the total number of different applications revealed by the study, because an application is counted more than once if it occurs under more than one principle. However, no duplication of applications occurs under any one principle.

Table VI shows (1) a sampling of the 246 principles which received values in this section of the investigation, (2) the

TABLE VI

THE RELATIVE VALUES OF PRINCIPLES OF PHYSICAL SCIENCE AS DETERMINED BY THE NUMBER OF APPLICATIONS ASSIGNED TO EACH *

Principles and Applications	Relative Value of Principle
Dark, rough, or unpolished surfaces absorb or radiate energy more effectively than light, smooth, or polished surfaces	21
Applications	
1. Why steam and hot water radiators are painted in dull dark color.	
2. Why light colored clothing is cooler than dark.	
3. Why oil storage tanks are painted a light color.	
4. Why teapots are made shiny on the outside.	
5. Why refrigerators are made smooth and white on the outside.	
6. Why it is much warmer in a greenhouse than outside even though no artificial heat is supplied.	
7. Why a thermos bottle keeps hot things hot and cold things cold.	
8. Why nickel plating on a stove renders it less efficient.	
9. Why the earth cools off at night.	
10. Why the air is cooler than the ground on a sunny day.	
11. Why the interior of a closed automobile becomes very warm if the car is allowed to stand for some time in bright sunshine on a cold winter day.	
12. Why aluminum paint is frequently used on the outside of railway coaches used in warm climates.	
13. How a hot water heating system heats a home.	
14. How a steam heating system heats a home.	
15. Why snow covered with soot or ashes melts more rapidly than clean snow.	
16. Why desert nights are cool.	
17. How hot beds are able to maintain a temperature above that of the surroundings.	
18. How a stove heats a room.	
19. Why dark colored roads are harder to see at night than light colored roads.	
20. Why white or yellow strips are often painted down the middle of paved highways.	
21. Why winter nights are lighter when the ground is covered with snow.	
The properties of alloys are dependent upon the relative amounts of their components, the extent of their compound formation and upon the crystalline structure of the mixture	24
Applications	
1. Why an alloy of iron and nickel is used for lead-in elements in electric light bulbs.	
2. Why the heating elements of electric irons, toatsters, etc., are made of nichrome wire.	
3. Why cast iron breaks more readily than steel.	
4. Why type metal is made of an alloy of lead, tin and antimony.	
5. How automatic sprinkler systems operate.	
6. How steel is tempered.	
7. How "tool steel" differs from the steel used in building construction.	
8. Why "stainless steel" does not rust.	
9. Why the best measuring instruments are made of "invar steel."	

* This table is intended merely to show the form of the extensive table included in the dissertation, which presents similar data for each of the 246 principles evaluated.

TABLE VI—Continued

Principles and Applications	Relative Value of Principle
10. How steel differs from iron.	
11. Why manganese-bronze ship propellers do not corrode in salt water.	
12. How "sterling silver" differs from pure silver.	
13. Why "18 carat" gold wears better than "24 carat" gold.	
14. Why electrical fuses and plugs in sprinkler systems melt at low temperatures.	
15. Why solder melts at low temperatures.	
16. Why cheap jewelry is made of brass.	
17. Why "duraluminum" is widely used in the construction of dirigibles and metal airplanes.	
18. Why gold and silver coins are not pure metal but are alloyed with other metals.	
19. Why babbit bearings are superior to iron or steel bearings.	
20. Why monel metal is used for heads of golf clubs, table knives, steam table tops, display case tops, etc.	
21. What "german silver" is composed of.	
22. How automatic asbestos or metal fire curtains operate.	
23. How fuses are used in electrical circuits.	
24. Why safes and armor plate are made of manganese steel.	
The earth's surface may be elevated or lowered by interior force	9
Applications	
1. How volcanoes change the surface of the earth.	
2. How earthquakes change the surface of the earth.	
3. Why most valuable mines are located in mountainous regions.	
4. How mountain ranges have been formed.	
5. Why layers of stratified rock occur on top of some of our highest mountains.	
6. Why the eastern coastline of the United States is gradually sinking while the western coastline is gradually rising.	
7. Why earthquakes often occur along certain seacoasts.	
8. What causes volcanic eruptions.	
9. How plateaus are formed.	

list of applications assigned to each of these principles, (3) the relative value of each principle as determined from the number of applications assigned to it.

The twenty principles receiving the highest ratings in this section * of the investigation follow in the order of their importance:

1. A fluid has a tendency to move from a region of high pressure to one of lower pressure; the greater the difference, the faster the movement.
2. Solids are liquefied and liquids are vaporized by heat; the amount of heat used in this process, for a given mass and a given substance, is specific and equals that given off in the reverse process.
3. Oxidation always involves the removal or sharing of electrons from the element oxidized while the reduction always adds or shares with the element reduced.
4. Oxidation and reduction occur simultaneously and are quantitatively equal.
5. The materials forming one or more substances, without ceasing to exist, may be changed into one or more new and measurably different substances.
6. Every pure sample of any substance, whether simple or compound, under the same conditions will show the same physical properties and the same chemical behavior.
7. Heat is transferred by convection, in currents of gases or liquids, the rate of transfer decreasing with an increase in the viscosity of the circulating fluid.

* In the remaining sections of this investigation, the results of the evaluation which has been described were synthesized with the results obtained in eleven earlier research studies in the field of science education. Since general conclusions are obviously influenced by the remaining divisions of the study, none are presented at this point.

8. Heat is conducted by the transfer of kinetic energy from molecule to molecule.
9. When two bodies of different temperature are in contact there is a continuous transference of heat energy, the rate of which is directly proportional to the difference of temperature.
10. When waves strike an object, they may either be absorbed, transmitted, or reflected.
11. Most bodies expand on heating and contract on cooling; the amount of change depending upon the change in temperature.
12. The pressure in a fluid in the open is equal to the weight of the fluid above a unit area including the point at which the pressure is taken; it therefore varies as the depth and average density of the fluid.
13. Electrons will always flow from one point to another along a conductor if this transfer releases energy.
14. The volume of an ideal gas varies inversely with the pressure upon it, providing the temperature remains constant.
15. The solubility of solutes is affected by heat, pressure, and the nature of the solute and solvent.
16. Elements and compounds to which the cells of living organisms react specifically produce physiological effects.
17. Condensation will occur when a vapor is at its saturation point if centers of condensation are available and if heat is withdrawn.
18. A body immersed or floating in a fluid is buoyed up by a force equal to the weight of the fluid displaced.
19. Sliding friction is dependent upon the nature and condition of the rubbing surfaces, proportional to the force pressing the surfaces together, and independent of area of contact.
20. Suspended particles of colloids have a continuous, erratic movement due to colloidal and molecular or ion impacts.

THE ROLE OF THE SCIENCE TEACHER IN HOME DEFENSE

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In modern wars the problem of home defense is a real one, especially in the so-called "target areas" where bombs and even gas may be expected. It does not seem likely that even such areas in continental United States will be subjected to continuous bombing, such as has been experienced in European and Asiatic countries, but there is considerable likelihood that that new weapon in this new type of war, namely, panic, may be employed. We in the United States like to think that we are a literate nation and yet we have reason to wonder if this is true when we observe the evidence of superstition and unfounded fear with which we are daily surrounded. We have only to recall Orson Wells' famous broadcast of the "Men from Mars" to help us imagine what could happen in many urban areas which might be bombed or subjected to the insidious machinations of fifth columnists.

During this war our citizens may find it necessary to fight bombs, fire, injuries, gas and panic in their own immediate community without the aid of normal services. That citizenry must be informed, and already there are appeals for someone to tell them what to do and how to do it. Civilian defense agencies for months have been attempting to organize and instruct the people, and although great strides have been made, in many places it has been an uphill battle. Even after the outbreak of the war, complacency was evident. There must be no hysteria, of course, but there must be a realization of potentialities and preparation for all phases of the disaster which may at any moment fall upon us.

There is a job for teachers in this country, in which some are already engaged; that of informing the populace as to how it may take care of itself under conditions which we ourselves have never experienced. We must train the members of our respective communities to fight bombs, gas, fire and perhaps most of all, panic. Science teachers by the very nature of their work and training are especially well suited to conduct courses of instruction in the essen-

tials of home defense and for that matter in the training of Wardens. In some cases teachers are now conducting entire courses alone, but it appears to be more satisfactory to form a team of five or six science teachers from the different subject matter fields, each to specialize in one field, thereby being better informed and more able to intelligently and satisfactorily answer the questions which always are asked.

A satisfactory plan of operation is to offer church groups, clubs, P.T.A. organizations, and the staffs of large institutions such as hospitals, asylums, *et cetera,* a series of five or six lectures. Demonstrations and exhibitions of fire extinguishers, models of incendiary bombs, first aid procedures and organization charts are very helpful. The selection of science teachers to be assigned to the various lectures falls naturally into the following groups:

- Home Defense Organization — Any science teacher
- Home Fire Protection — General Science teacher
- First Aid and Home Hygiene—Biology teacher
- Blackouts and Evacuations—General Science teacher
- Bombs and Gas Protection—Chemistry or Physics teacher
- Map Making and Reading—Earth Science teacher

HOME DEFENSE ORGANIZATION

The local, state and national civilian defense organizations are now set up and in operation in most places. However, it is important that the general public understand and appreciate the function, duties and powers of such agencies if they are to properly cooperate with them. This is especially true since many branches of civil defense are without authority. Factors concerning which the public should be informed are as follows:

- Wardens
  - The need for Wardens
  - Organization and ranks
  - Duties during emergencies
  - Attitude of the public during surveys by Wardens
- Air Raid Protection Services
  - Mayor or other executive officer
  - Headquarters or A.R.P. system
  - Control and Communication
    - Control center
    - Report center
  - Wardens
  - Protection services
    - Fire protection
    - Casualty—first aid
    - Catastrophe units
    - Rescue and repair
    - Decontamination squads
    - Demolition parties
- The Warden Post System
  - Chief Warden
  - Senior Post Wardens
  - Post Wardens

HOME FIRE PROTECTION

Perhaps the greatest single contribution can be made here by the science teacher. Even during peace time thousands of lives are lost and hundreds of millions of dollars of property damage is done each year in the United States. Should this great educational program do no more than make the citizens of this country more aware of fire hazards, the causes of fire, how to prevent fire and how to properly inform the fire department of the existence of fire, it would represent time well spent. The following outline includes the essentials for home defense:

- Seriousness of fire in peace time
  - Vital statistics
  - Financial loss
- Chief causes of fire
  - Smoking carelessness
  - Ignition of vapors
  - Defective wiring
- Fire hazards
  - Inspection of attics, cellars, garages
- Classes of fires
  - A—Common combustibles
  - B—Oils, greases, inflammable liquids.
  - C—Electrical
- Factors necessary for any fire
  - Combustible substance
  - Kindling temperature
  - Oxygen
- Fire extinguishers for each class of fire
- Fire fighting rules
- Searching for victims
- Opening doors in burning buildings
- Incendiary bombs
  - Purposes
  - Construction and chemical action
  - Fighting the bomb

Chemical "post cards"
Use of the stirrup pump
Burning clothing
Sending in fire alarms

FIRST AID AND HOME HYGIENE

Although first aid units will undoubtedly be located in various parts of communities where attacks might be expected, the necessity for treating his own injuries or those of members of his family may become a daily affair for any citizen. First Aid Courses offered by the American Red Cross should of course take preference, but in lieu of such opportunities the following outline is suggested:

The purpose of first aid
Accident prevention
Injuries requiring speed
- Severe bleeding
- Cessation of breathing
- Poisons

Sending for the doctor
- Location of victim
- Nature, cause and extent of injury
- Aid that has been given
- Equipment on hand

Use of alcoholic stimulants
Treatment of wounds
- Washing
- Use of iodine
- Dressings

Infections
Fractures
- Simple
- Compound
- Back or neck

Sprains
Nosebleed
Blisters
Convulsions in children
Choking
Hysteria
Bruises
Fainting
Home medicine closet
Food poisoning
Water supply
Sanitation

BLACKOUTS AND EVACUATIONS

Lights, of course, are of great aid in aerial navigation for determining direction and position. It is said that the light from the flame of a match can be seen at an elevation of 1,500 feet. In case blackouts are adopted as a policy of air defense, they must be complete. It is therefore essential that the populace be made aware of the necessity of complete blackouts and how they may be obtained.

Reason for blackouts
Normal life activities must go on
Methods of blacking out
- External lights
- Traffic lights
- Aids to traffic movement
- Automobile lights
- Internal lights
- Shading indoor lights
- Materials to use

Refugee rooms
Enforcement of regulations
- Cooperation of the public
- Enactment of laws

No one knows whether or not evacuations will be necessary, but plans for the mass movements of large groups of people must be laid down. There are three categories into which evacuees will fall and provisions must accordingly be made for transporting and caring for these people. The first class would include the aged, the blind, hospital cases and bedridden individuals. The second class includes children, mothers with babies, and expectant mothers, while the third class would be made up of those individuals who are able bodied but not needed for defense work in the danger areas and those assisting in the evacuation, such as teachers, nurses and attendants. Instruction should be given in properly preparing children for evacuation, such as in the use of warm clothing and essential food supply.

PROTECTION AGAINST BOMBS AND GAS

Bombs may be divided into three classes, namely, high explosive, incendiary and gas bombs. The great danger is not from direct hits with high explosive bombs, but from the splinters or fragments from exploding bombs, the debris which is thrown up by them and the falling anti-aircraft shells. It is said that but 10 per cent of the British population make use of bomb shelters because they feel they are quite safe in a properly barricaded home. Very likely many people in the United States will follow a similar plan. Effective fight-

ing of bombs and gases depends upon a knowledge of construction, composition and action of each of these weapons. The following outline should provide such information:

- Chemical agents
  - Gases
    - Tear gases or lachrymators
    - Lung irritants
    - Vesicants (blistering or burning)
    - Respiratory
  - Smoke
  - Other chemical agents
  - Medical aspects
- Dissemination of gases
  - Bombs
  - Sprays
- Detection of gases
- Protection against gas

- Explosives
  - Principal high explosives
    - T.N.T.
    - Amatol
    - Ammonium Picrate
    - Tetryl
    - Mercury Fulminate
    - Lead Azide
    - Nitrostarch
    - Picric Acid
    - Tridite
  - Fragmentation bombs
  - Demolition bombs
  - Chemical bombs
    - Gas
    - Incendiary
  - Protection against bombs

MAP MAKING AND MAP READING

It may be necessary for many people in the months to come to prepare and to read maps of their communities. Emergency equipment, report stations, telephones, fire boxes, dead end streets and innumerable items of like nature will appear on local maps in the very near future. Very likely, any information of this sort would be given to Wardens, rather than the general public.

- Description of maps
- Use to Wardens and others
- Preparation of maps
- Field work
- Establishment of a base line
- Scales and symbols
- Lettering
- Abbreviations

The preceding is, of course, only the barest outline of what undoubtedly will become a great educational undertaking throughout the United States. Science teachers are the logical persons to step into the breach in order that such vital information may quickly reach the public. Lectures of this sort are well attended and attention is undivided. In many communities the defense agencies have prepared courses of study or at least outlines are available. This, however, is not universally true, and for that reason a list of agencies which are issuing valuable materials for use to teachers of such courses is appended in addition to a partial bibliography.

The following agencies are among many that issue defense information.

1. United States Office of Civilian Defense, Washington, D. C.
2. State Defense Councils, State Capitol
3. County Defense Councils, County Seat
4. Local Defense Council, City Hall
5. Local Fire and Police Departments
6. Local Public Utilities- Gas, Electric, Telephone
7. American Red Cross, Branch Offices
8. Various Insurance Companies
9. Public Libraries
10. Office for Emergency Management, Washington, D. C.
11. United States Office of Education, Washington, D. C.
12. United States Information Service, Washington, D. C.
13. Superintendent of Documents, Government Printing Office, Washington, D. C.
14. Chamber of Commerce of the United States Insurance Department, Washington, D. C.
15. Civilian Advisory Service, 41 Park Row, New York City
16. British Library of Information, 30 Rockefeller Plaza, New York City
17. National Board of Fire Underwriters, 85 John St., New York City
18. National Fire Protection Association, 60 Batterymarch St., Boston, Mass.

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Handbook for Air Raid Wardens. Washington: United States Office of Civilian Defense, 1941. 25 p. 10c.
Manual for Officers Responsible for A.R.P. Training. New York: British Library of Information, 1940. (Rev. ed., paper), 15c.
Wachtel, C. *Air Raid Defense.* New York: Chemical Publishing Company, 1941. 240 p. $3.50.
Protection of Industrial Plants and Public Buildings. Washington: United States Office of Civilian Defense, 1941. 7 p. (free).
What to Do in an Air Raid. 7 p. (free).
Meet Your Air Raid Warden. 1 p. (free).
Moulton, Robert S. *(General Editor). Handbook of Fire Protection.* Boston: National Fire Protection Association, 1941. 1308 p.
Bond, Horatio. *Fire Defense.* Boston: National Fire Protection Association, 1941. 221 p. (Paper) $1.50.
Civilian Defense; Suggestions for State and Local Fire Defense. Fire Series Bulletin No. 1. Washington: Superintendent of Documents, Government Printing Office. 10c.
Zanetti, J. E. *Fire From the Air.* New York: Columbia University Press, 1941. 50c.
Selected Papers from the 1940 Indiana Fire School held at Purdue University. Lafayette: Purdue University English Extension Department, 1940. 77 p. (free).
Domestic Oil Heating. Washington: Chamber of Commerce of the United States Insurance Department, 1941. 4 p. (free).
Emergency Fire Defense. Washington: United States Office of Civilian Defense, 1941. 17 p. mimeographed (free).
Bulletins of the National Board of Fire Underwriters, New York.
Am I My Brother's Keeper? (free).
Fire! Fire! 8 p. (free).
Let's Save a Life at Home. 8 p. (free).
2 Minutes by Tick. 8 p. colored (free).
Your Life and Property, Are They Safe From Fire? 4 p. (free).
Safeguarding the Home Against Fire. Rev. ed. 1940. 86 p. ill. (free).
Safeguarding the Nation Against Fire. (Manual for High Schools), 1940, rev. ed. 134 p. (free).
Somewhere a Home Is Burning. 9 p. (free).
Shelter at Home. New York: British Library of Information, 1941. 20 p. 10c.
Air Raid Shelters; Defense Bibliography No. 1. Los Angeles: City Hall, 1941. 8 p. 10c.
National Defense, a list of bibliographies on questions relating to defense. Washington: Library of Congress, Division of Bibliography, 1941. 21 p. mimeographed (free).
Emergency Medical Service for Civilian Defense. Medical Division Bulletin No. 1. Washington: United States Office of Civilian Defense, 1941. 9 p. (free).

PRACTICES AND TECHNIQUES IN SCIENCE TEACHING *

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A study of the practices and techniques prevalent in the teaching of science in the secondary schools of Minnesota has been recently completed. The study consists of an analysis of data obtained from the science teachers of the State on the practices and techniques which they were employing in the teaching of their science classes.

The necessary information for the study was obtained by means of a questionnaire which was constructed about such points as objectives, attainment of objectives, sequence of science subjects, grade placement, classroom methods of teaching, laboratory methods of teaching, instructional devices, motivating devices, science library, science periodicals, and use of examinations. A total of 277 questionnaires were returned—246 from science teachers in public schools and 31 from science teachers of private schools. The returns from the

* Condensed from A Study of the Practices and Techniques Prevalent in the Teaching of Science in the Secondary Schools of Minnesota by the author. Master's Thesis, University of Minnesota, 1938. 116 p.

private schools were treated apart from and compared with the public schools.

Figures 1 and 2 give a summary of the results in regard to classroom methods being employed by the science teachers. Figure 1 gives the percentage of teachers using a particular method while figure 2 shows the extent to which any particular method is used by these teachers. The figures seem to indicate that the teachers used a variety of methods with most emphasis on class discussion, supervised study, and text-assignment and recitation. The project method was used by a rather large percentage of teachers in general science and biology but as figure 2 indicates it isn't used as extensively as class discussion, supervised study, and text-assignment and recitation. In the questionnaire the various methods mentioned were clearly defined so as to avoid confusion.

In attempting to determine the laboratory methods used a similar procedure was followed as indicated in the case of class-

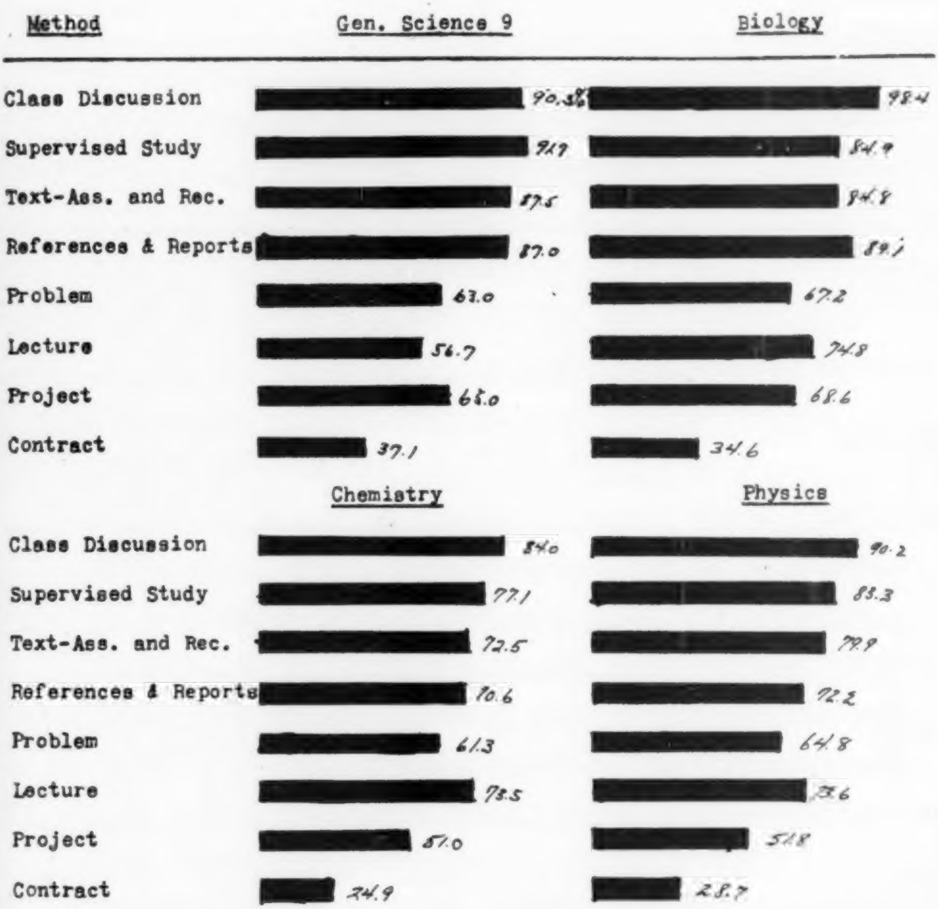

FIGURE 1.—The extent to which the various methods are used by the science teachers in the secondary schools of Minnesota.

room methods. It was found that in general science the outstanding method being used was that of teacher-demonstration with 94.5 per cent of the teachers indicating its use. The method of pupil-demonstration was used by 69.6 per cent of the teachers with individual laboratory work and group laboratory work used very little.

In biology the predominating laboratory method was again that of teacher-demonstration with 88.2 per cent of the biology teachers reporting its use. The method, however, was not used as extensively as in general science. Group laboratory work and individual laboratory work were found to be used rather extensively in biology with pupil-demonstration being used only moderately.

In chemistry and physics the method of teacher-demonstration again predominated but the extent to which this method was used was not as great as in biology and general science. The number of teachers which reported the use of the group and individual laboratory methods was slightly less than that of teacher-demonstration, but they also indicated that they used the methods more extensively than that of teacher-demonstration.

In regard to grade placement of science courses, general science was found as a required course in grades seven, eight, and

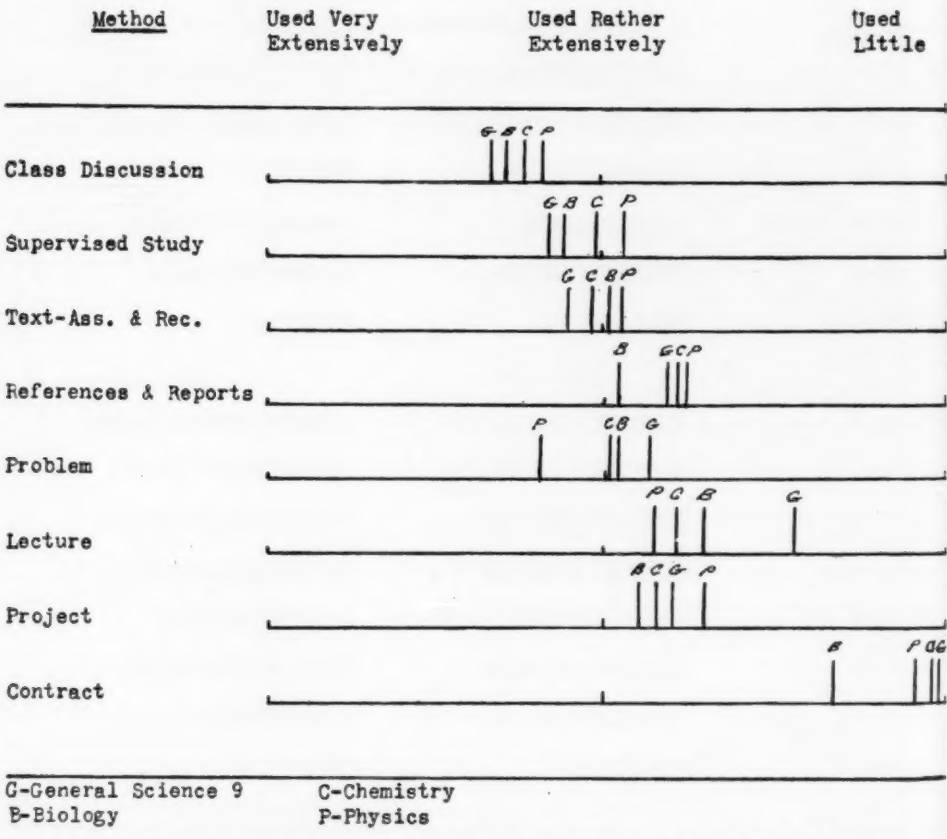

FIGURE 2.—Graphic representation of the extent to which the science teachers in the secondary schools of Minnesota use the various methods of teaching.

nine in practically 100 per cent of the schools studied. In the seventh grade 91.7 per cent reported two periods per week, in the eighth grade 86.0 per cent reported three hours per week and in the ninth grade 98.5 per cent reported five periods per week. Biology was found to be predominantly a tenth grade course with 94.3 per cent of the schools offering it in this grade. It was found to be an elective (57.3 per cent) course more often than a required (42.7 per cent) course. Of 139 biology courses reported 80.5 per cent were taught on the five period per week plan and 19.4 per cent on the seven period per week plan. The data show that there was no definite grade placement of physics and chemistry. They were both found with almost the same frequently in the eleventh and twelfth grades. Of 123 chemistry courses reported 86.9 per cent were taught on the five period per week plan and 13 per cent on the seven period per week plan. About the same situation exists for physics. The larger schools were almost 100 per cent on the five period per week plan.

In regard to textbooks and laboratory manuals it was found that 92.1 per cent of the teachers responding used a basic text for their science classes. Those that did not use a basic text made use of such devices as workbook with textbook references, several texts, teacher-constructed work sheets, etc. In general science the three book series by Wood and Carpenter was found to be most popular with 56.8 per cent of the classes using one of the three as a basic text. In biology out of a total of 14 texts reported the first three ranking texts were *New General Biology* by Smallwood and others, *Biology For Today* by Curtis, Caldwell and Sherman, and *A Learning Guide In Biology* by Downing and McAtee. In the physical sciences the range of texts in use was smaller than in either biology or general science. In chemistry the text *First Principles Of Chemistry* by Brownlee and others was used by 53.6 per cent of the chemistry teachers reporting, with *Dynamic Chemistry* by Biddle and Bush and *Chemistry For Today* by McPherson, Henderson and Fowler ranking second and third respectively out of a total of eight texts reported. In physics *New Physics In Everyday Life* by Henderson was used by 40.2 per cent of the physics teachers reporting with *First Principles of Physics* ranking second (22.5 per cent) out of a total of nine texts reported.

Table I gives a summary of the methods used in instructing and recording the laboratory work done by the science classes. A study of the table shows that in general science the most commonly used method was that of having the students answer a series of questions about the experiment. In biology, chemistry, and physics the combination laboratory manual and workbook was used more frequently than any other method. The traditional laboratory manual with detailed directions of procedure was still used considerably in chemistry and physics.

In regard to the science library it was found that of 212 schools reporting 161, or 75.9 per cent, indicated they had a science library. Of these 161 schools 123, or 75.3 per cent, indicated that it was a part of the general library, 15, or 9.3 per cent, stated that it was a science classroom library, while 24, or 14.9 per cent, stated that it was both a part of the general library and a science classroom library. This means that 24.2 per cent of the schools studied used the technique of a classroom library. Half of the teachers (50.2 per cent) reporting allow the students to leave the classroom individually and go to the library for reference work on science topics and problems, but these teachers also indicated that they only use the method occasionally. Many teachers (88 per cent) indicated that they frequently use the method of borrowing books from the library to use in the science classroom during the study of a particular unit.

TABLE I

THE FREQUENCY WITH WHICH THE VARIOUS METHODS WERE USED IN INSTRUCTING AND RECORDING THE LABORATORY WORK DONE IN THE SCIENCE CLASSES OF THE SECONDARY SCHOOLS OF MINNESOTA

Methods	Gen. Sci. 9		Biology		Chemistry		Physics	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Lab. manual with detailed directions of procedure	9	4.7	11	5.5	31	16.6	26	17.2
Manual with lab. notebook	9	4.7	16	8.0	9	5.4	9	5.9
Combination lab. manual and workbook	26	13.5	85	42.5	81	48.6	59	38.9
Lab. manual with blanks for recording data	4	2.2	11	5.5	16	10.8	16	10.6
Teacher constructed lab. guide sheets	33	17.3	29	14.5	3	1.8	12	7.9
Science workbooks	23	11.9	22	11.0	13	9.8	13	8.6
Answering a series of questions about the exp.	71	36.9	21	10.5	11	6.6	15	9.9
Student notebooks	9	4.7	3	1.5	—	—	2	1.3
Lab. exp. from text with student notebook	6	3.2	1	.5	—	—	—	—

TABLE II

THE FREQUENCY OF THE VARIOUS USES MADE OF TESTS BY THE SCIENCE TEACHERS IN THE SECONDARY SCHOOLS OF MINNESOTA

Use	Number	Per Cent
As a basis for marking	217	91.1
Measuring the achievement and progress of pupils	213	88.7
To test the efficiency of your own teaching	199	83.6
As an aid in reviewing material	189	79.4
Diagnosing the difficulties of individual pupils	174	73.1
As a basis for promotion	99	41.6
To set up norms of achievement for different classes	50	21.0
As a means of motivation	6	2.5
As a learning technique	3	1.3

Table 2 gives the data for the various uses which the science teachers made of the examinations they give. The technique of giving a five or ten minute quiz at the beginning of the class period was reported as used by 77.8 per cent of the teachers. The practice of giving a pre-test at the beginning of a course to determine what the student already knows about the subjest was not used very extensively as indicated by the fact that only 37 per cent of the teachers reported its use. The practice of handing back examination papers and discussing the errors with the pupils was indicated as used by 98 per cent of the science teachers.

Some other conclusions drawn from the study are as follows: (a) the science courses of study were organized on the unit plan, (b) very few specialized science

courses were found in the secondary schools, (c) the textbooks were all of recent publication dates, the median years ranging from 1932 to 1936, (d) the science teachers made considerable use of such motivating devices as newspaper clippings, the science bulletin board, charts, field trips and visits to industrial plants, but little use of the silent and sound movie and the microprojector, (e) such periodicals as *Popular Science, National Geographic, Popular Mechanics,* and *Nature Magazine* were used extensively by the students in preparing the work of their science classes, (f) to provide for individual differences, the science teachers emphasized special reports, supplementary references and readings, and special projects with little emphasis placed on homogeneous grouping and differentiated assignments, and (g) in the practices and techniques discussed in this study there was little difference found between the public schools and the private schools.

INTEGRATED INTERPRETATION OF DATA TESTS *

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For several years the Progressive Education Association has published a series of tests to be used in evaluating the students' ability to interpret a given set of data. Each test contains a number of problems taken from various fields, such as natural science, political science, economics, *et cetera.* As yet no tests are available that cover specific units only. The author felt it desirable, however, to integrate interpretation of data tests into the subject matter and therefore developed a series of eight tests for a unit on foods in a second semester chemistry course. Since the students are supposed to adhere strictly to the data presented in the test and not to use any outside knowledge, the tests do not contain any subject matter that was taken up previously in class. The tests thus offer at the same time a valuable teaching aid for the presentation of some detailed problems of subject matter which otherwise might not have been covered. The following items were included in the eight tests on food data: (1) Development of food prices, (2) A study of tooth decay, (3) Feeding experiments with polished rice, (4) Nitrogen elimination in rats, (5) Saccharimeter readings, (6) Influence of milk in the diet, (7) Human energy needs, and (8) Minerals used up in the growth of various crops.

* This study was made at the University High School, Oakland, California, while the author was located there.

PREPARATION OF THE TESTS

Since the students are not familiar with this type of test, particular care has to be taken to give detailed instructions. The following instructions were therefore handed out at the beginning of the test program:

"This is a test of your ability to interpret data. On the following pages eight sets of data are presented each of which is followed by a number of statements. The data given may be insufficient with respect to certain statements. This has been done intentionally in order to prepare you for similar situations in your study or in life. In evaluating the statements in the following terms do not use any outside knowledge:

T....if the evidence is sufficient to make the statement true,
PT..if the evidence suggests that the statement is probably true,
I.....if the evidence is insufficient for a decision,
PF..if the evidence suggests that the statement is probably false,
F....If the evidence is sufficient to make the statement false."

Each test contains fifteen items, chosen from the following list:

Group	Item	Response
A	Comparison of points and trends	T, F
B	Generalization	T, F
C	Interpolation	PT, PF, I
D	Extrapolation	PT, PF, I
E	Sampling	PT, PF, I
F	Analogy, cause, effect, purpose, irrelevant statements	I

As an example, one of the tests is presented below:

Diet experiments on Japanese naval vessels showed the following results:

Group	Diet	Cases of beri-beri
1	Polished rice only (without hull)	60%
2	95% polished rice and 5% vegetables and meat	20%
3	90% polished rice and 10% vegetables and meat	5%
4	50% polished rice and 50% vegetables and meat	None
5	Whole rice only	None
6	Polished rice and vitamin B	None

Statements:

1. Vegetables and meat contain vitamin B.
2. The Japanese are especially susceptible to beri-beri.
3. A diet containing more vegetables and meat than polished rice prevents beri-beri.
4. The rice hull contains a beri-beri preventing substance.
5. If vitamin B had been added to the diet in group 5, some cases of beri-beri would have developed.
6. With a lower percentage of polished rice in the diet, we find more cases of beri-beri.
7. After 5 per cent vegetables and meat were added to the diet of polished rice, the cases of beri-beri were reduced by more than half.
8. An increase of vegetables and meat up to 49 per cent would have completely eliminated beri-beri.
9. The use of fresh vegetables is more helpful in preventing beri-beri than the use of canned vegetables.
10. The polishing of rice infects the rice kernel with the beri-beri germ.
11. If the diet had consisted of 90 per cent polished rice and 10 per cent beef stew, 5 per cent of the sailors would have gotten beri-beri.
12. The substitution of barley for rice would have caused similar results.
13. A diet of only polished rice leads to scorbute, too.
14. These experiments are not applicable to the entire population of Japan.
15. A diet of only polished rice weakens the resistance of the human body.

Responses:

Statement No.	Correct Response	Item Group	Item
1	I	E	Sampling
2	I	F	Irrelevant statement
3	PT	D	Extrapolation
4	T	B	Generalization
5	PF	E	Sampling
6	F	A	Comparison of points
7	T	A	Comparison of points
8	PT	C	Interpolation
9	I	F	Effect
10	I	F	Cause
11	PT	E	Sampling
12	I	F	Analogy
13	I	E	Sampling
14	PF	E	Sampling
15	I	F	Cause

PRESENTATION OF THE TESTS

The tests were presented to two classes of twenty-four students each at University High School, Oakland, California, in the spring of 1941. The students, who had previously had one semester of general chemistry, do not intend to continue with science when or if they go to college. The course has therefore been adapted to their practical needs and includes units on water, foods, textiles and cleansing agents.

Every week one or two tests were given. The testing program thus was carried on throughout the whole unit on foods. The test took about fifteen minutes and was followed by a thirty minute discussion, which was considered the most valuable part of the whole program.

The rest of each test period was devoted to a follow up, in which the students analyzed and summarized their responses on two sheets. Sheet 1 contains the analysis of each individual test and sheet 2 contains the summary of all tests. The students were thus able to follow their progress and to see whether they were too cautious or whether they went beyond the data.

RESULTS

In order to measure the improvement of the student's ability to interpret data, a

general interpretation test of the Progressive Education Association (No. 2.52) was given before the first test on foods. Concluding the test program was an alternate test of the Progressive Education Association (No. 2.51). Before the presentation of the results of these two control tests, an explanation of the terminology used seems necessary.

The correct responses are reported under the heading "General Accuracy," the wrong responses under the headings "Overcautious," "Going beyond Data," and "Crude Errors." The term overcautious is used for responses that should have been "True" or "False," while the student marked the statement "Probably True" or "Probably False" respectively. Of the same type are the statements that should have been marked "Probably True" or "Probably False," but were marked "Insufficient." These responses are typical of the student who is not sure of himself. The student, on the other hand, who is too sure of himself and does not recognize the limitations of data, is liable to make mistakes of the "Going beyond Data" type. Here belong responses that should have been "Insufficient" while the student marked the statements "Probably True" or "Probably False," and responses that should have been "Probably True" or "Probably False," while the student marked the statements "True" or "False." Under the heading "Crude Error" all the mistakes are reported that are due to misreading or misunderstanding of a statement or of the data; e.g., a statement was marked "True" when the correct response should have been "False," or vice versa.

TABLE I

CONTROL TESTS

Name of Stdt.	I.Q.	General Accuracy		Crude Error		Overcautious		Going Beyond Data	
		Test No.		Test No.		Test No.		Test No.	
		2.52	2.51	2.52	2.51	2.52	2.51	2.52	2.51
		4-1 *	5-21 *	4-1 *	5-21 *	4-1 *	5-21 *	4-1 *	5-21 *
D.A.	107	38	53	14	11	37	23	51	33
B.B.	105	28	56	12	8	16	28	78	31
M.Bi.	114	41	63	8	8	24	25	59	25
M.Br.	115	45	61	11	6	38	24	37	35
R.B.	117	44	59	11	9	22	16	53	41
C.C.	106	34	59	16	6	30	35	59	27
E.C.	136	48	67	12	9	40	17	35	27
J.C.	130	44	57	7	11	33	28	50	30
D.E.	110	41	57	12	12	18	30	62	26
H.E.	109	30	47	26	14	15	30	68	40
S.F.	111	53	54	8	17	31	33	39	31
J.G.	136	44	73	11	7	16	17	61	22
G.H.	100	49	62	9	8	48	22	30	33
K.H.	115	39	55	21	15	27	27	45	31
L.H.	138	49	72	5	6	8	14	65	26
M.H.	109	42	53	19	19	34	24	43	28
O.H.	112	60	66	8	9	20	25	37	25
M.K.	101	10	33	7	17	20	35	32	50

* Date of test.

TABLE I—*Continued*

Name of Stdt.	I.Q.	General Accuracy		Crude Error		Overcautious		Going Beyond Data	
		Test No.		Test No.		Test No.		Test No.	
		2.52	2.51	2.52	2.51	2.52	2.51	2.52	2.51
		4-1 *	5-21 *	4-1 *	5-21 *	4-1 *	5-21 *	4-1 *	5-21 *
C.J.	100	38	52	11	17	35	31	38	17
M.J.	110	42	68	10	13	22	8	52	30
A.K.	115	47	56	25	8	31	35	42	26
E.L.	113	42	62	16	11	32	25	38	29
P.L.	112	49	60	16	12	29	20	40	28
S.La.	106	46	65	8	9	25	19	46	27
S.Le.	110	47	52	10	13	28	28	46	37
B.M.	111	39	56	10	8	24	28	61	44
D.M.	106	48	58	13	11	48	38	29	23
E.M.	106	50	60	14	16	44	20	29	31
J.Ma.	93	35	59	19	13	22	23	57	31
J.Mi.	88	32	48	24	17	23	35	61	34
L.M.	102	27	52	24	18	12	25	69	36
R.M.	93	44	53	13	11	43	36	38	30
S.M.	116	53	74	15	7	16	16	48	22
K.N.	113	50	64	16	10	24	20	38	29
D.O.	98	38	58	20	11	30	26	50	33
P.O.	104	52	56	6	17	40	32	44	24
D.P.	117	37	67	11	7	12	17	59	31
M.P.	114	64	67	7	9	14	16	37	23
M.R.	118	45	64	17	6	19	28	50	27
A.S.	102	40	48	17	22	18	27	46	36
B.Sh.	103	22	62	24	13	30	11	65	37
B.Sy.	94	38	57	22	14	10	33	66	24
H.S.	118	40	60	13	11	28	26	56	29
P.S.	98	36	57	22	15	28	24	53	27
C.T.	111	43	58	13	14	29	21	36	33
M.T.	109	38	60	19	10	26	32	53	24
P.V.	109	49	68	13	12	27	20	37	23
P.W.	104	34	59	22	11	14	16	68	33
Mean	109.7	41.8	58.9	14.3	11.6	26.3	24.8	49.1	29.9

* Date of test.

The scores are indicated in percentages of the total number of responses possible in that *particular* column. For example: A score of 50 in the "General Accuracy" column means that one half of the student's responses are correct. But a score of 50 in the column "Going beyond Data" does not indicate that the student went beyond the data in one half of *all* cases. It means only that the student did not recognize the limitations of data wherever he had a chance to go beyond them. Since he cannot possibly go beyond the data when the response should have been "True" or False," these cases are not counted in finding the percentage in the "Going beyond Data" column. The same system is applied in the columns "Over-

cautious" and "Crude Errors" where the "Insufficient" statements are omitted in the calculation of the percentage.

The following tabulation of the control tests does not include a special column for omissions since the students omitted on an average of only one third of one per cent of all statements.

SUMMARY

The mean "General Accuracy" increased from 41.8 in the first control test to 58.9 in the final control test. There was no student who did not show a gain; the smallest gain was 1.9 per cent (student S.F.) and the largest 181.7 per cent (student B.Sh.).

All three types of errors show a decrease. The overcautious students improved from 26.3 to 24.8. This gain is relatively small, probably due to the fact that the students were eager to avoid going beyond the data and thereby went too far toward the other extreme.

The "Crude Errors" decreased from 14.3 to 11.6. Since no improvement in reading can be assumed in such a short time, the higher scores result probably from a better understanding of this type of test.

Largely responsible for the higher "General Accuracy" in the final test is the improvement in the "Going beyond Data" column where the mistakes decreased from 49.1 to 29.9. It is hoped that this particular improvement will show a large transfer value and, if so, it might be considered the main achievement of the whole testing program.

The relationship between the intelligence of the student and his "General Accuracy" score was recorded in the form of two scatter diagrams. In diagram 1 the I.Q. was plotted against the "General Accuracy" in the first control test, and in diagram 2 the I.Q. was plotted against the improvement of the "General Accuracy" in the two control tests. Neither of the two diagrams revealed a significant relationship: The coefficient of correlation for diagram 1 was .33 and for diagram 2 only .07. In other words, the poorer students improved as much during the testing program as the better students, a fact which should be of considerable significance in making up science curricula.

The results of the eight food tests which were given between the two control tests are not stated in detail because the tests are not standardized and thus the results have only a limited value. The data are shown in summary form in Table II.

The results indicate an improvement similar to that in the control tests. The results of the interpretation of food data tests also reveal the two other major trends shown by the control tests, namely, the sharp decline of mistakes of the "Going beyond Data" type and the slight relationship between the I.Q. and the test scores.

In conclusion it may be said that the evidence from this testing program indi-

TABLE II

MEAN GENERAL ACCURACY IN FOOD TESTS

Test No.	1	2	3	4	5	6	7	8
Date of test	4–11	4–21	4–29	4–29	5–5	5–13	5–19	5–20
Gen. Accuracy	9.4	10.7	12.0	12.2	12.0	12.2	11.5	12.4

(Possible maximum: 15 points)

cates that the high school chemistry course can be considerably enriched by the use of integrated interpretation of data tests. Definitely measurable results can be achieved in such complex mental operations as "scientific thinking" and these results are not limited to the better students. There is every reason to assume a similar successful application in the biological sciences and social studies.

OUR CHANGING BIOLOGY

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While changes are taking place in the organization of every science course in high school, there is no course that is organized on more different plans than biology, unless it be general science. Because of the newness of biology, as compared with physics and chemistry, the subject may not have had sufficient time to find a generally accepted plan of organization. The writing of biology textbooks has been a fertile field for those who wished to present their personal viewpoints. And so we have today about as many plans for organization as there are texts on the market.

We have gone a long way from the early biology course consisting of a half year each of botany and zoology. The early biology textbooks had a carry-over of the early separation into plant study, animal study, and human physiology without a serious attempt at integration. The course in biology usually emphasized the special preference of the teacher and minimized those parts which he had dodged in college. The laboratory work was greatly influenced by courses in taxonomy, comparative anatomy, and morphology which the teacher had taken in college. A laboratory manual was followed and carefully-made drawings from microscope slides were not the exception but often the rule. The text and laboratory manual, usually written by college professors, were "weakened down" to the supposed abilities of high school students. It was hoped that the students would become college majors in the various fields of biological science which was carefully departmentalized and compartmentalized.

About this time a radical change came over the course in biology for high schools. It began to be the consensus of high school teachers that a course called biology should have a unifying plan of organization rather than being separated into its compartments. Living things have certain characteristics or processes in common and these became the basis for the organization. The emphasis began to be on physiology rather than morphology, on function rather than form. Such processes as food-getting, digestion, respiration, metabolism, circulation, growth, excretion, irritability, reproduction, and immunity were the basis of the new organization, the different forms of plant and animal life being used to illustrate these processes. In this new type of organization, the organism was never studied as a whole but to illustrate certain processes. In fact, it was common to use the same organism several times during the school year to illustrate different processes. The ameba, for instance, might be used to illustrate a simple type of food-getting; later it was used to illustrate irritability; and at a later time to show a simple type of reproduction. A carefully devised test showed that a student who had used this plan knew more about the ameba than one who studied the ameba just once under the old plan of organization.

The changes in the laboratory work were even more pronounced. If one were fortunate enough to have a well-equipped, college-type laboratory, it was easy to show an ameba every time it was called for in the outline, but more often the high school teacher had to resort to charts or drawings in the textbook. For the average high school laboratory, it was "an occasion" to see the ameba once, let alone three or four times during the year. And while the student was studying the ameba under the microscope, it was only a day's study to learn how it gets food, moves, is sensitive to certain outside stimulations, and reproduces in a simple way. And why should we drag in the ameba so many times in a high school biology course?

But for the teacher of large classes in biology in high school, the new plan was a relief. It was much easier to show pictures of an ameba several times during the year than it was to have an ameba once for laboratory study. It became the common practice to have several textbooks with good illustrations so that the resourceful teacher could illustrate most of the subjects studied in biology. With the decreased income for materials and equipment for the laboratory, the new type of biology was a life-saver. The workbook became popular and the usual exercise was to "read through the passage on page 141 and express your opinion of it." For the student to try experiments with living things, to examine and ask questions about animals and plants, to dissect any organisms and make drawings—even to make collections of insects, flowers, or bird-records—became a thing of the past.

Under the new type of organization, there was little opportunity for the study of living things because they were not available for study when it came time in the outline. A course in physics or chemistry can be organized systematically and logically and the principles can be observed at any time of the year. But life is seasonal. The birds migrate in the spring and begin mating and nest building. Insects lay their eggs or go into hibernation in the fall and are gone for the winter. Human experiences are so tied up with the seasonal activities, our health is so dependent on protection from colds in the winter time, that we cannot ignore the seasonal idea in any course based on life.

If biology is to be a study of life, it must take into account the most common phenomena of all life, its adaptations to the "changing seasons." Living things interact with the environment in which they live, and this includes climate, soil, other plants and animals, and man. They go through processes which are seasonal, just as the farmer plants his crops and harvests them in due season. Instead of having different forms of life to illustrate different life processes as they may be planned in the outline, is it not just as good teaching to use a plant or animal to illustrate the different life processes and study the living thing in its entirety? In one case you repeat the organism while in the other you repeat the biological principle. If it is your plan to teach biological principles, is it not better to repeat the principle? If it is your plan to emphasize the organism, that should be repeated for emphasis, or for drill in the old way.

In order to make these suggestions take more definite form, a series of questions tending to direct attention to this seasonal plan of organization is submitted below. This is followed with a few guiding principles for a course in high school biology. The final suggestion is an outline of a course in biology that attempts to follow the "best general plan" of organization. Suggestions and criticisms will be appreciated. Will the plan suit the particular environment in which you teach? Will it suit the particular community needs? Will it suit the interests and abilities of high school students? Will it develop a lasting interest in a study of living things?

QUESTIONS ON SEASONAL BIOLOGY

REASONS FOR THIS TYPE OF ORGANIZATION SUGGESTED

1. Should biology be a study of living things?
2. Should the living things be studied at a time when they are abundant in nature, and at the most favorable time for study?
3. What should be the point of emphasis of study of living things?
   a. Similarities to the structure of man?
   b. Economic importance to man?
   c. Their anatomy or structure?
   d. How they carry on their life-processes and meet their own difficulties?
   e. Biological processes or principles illustrated by these typical forms?
   f. As part of the changing stream of life that adjusts itself to conditions of the environment and is used by man for his own purposes, or influences man?
4. In the selection of material for study should we
   a. Select the unusual or the commonplace?
   b. Choose for study that in the local environment or attempt to elect from all environments even though not found locally?
   c. Select that form that best illustrates the principles involved and that is available in the local environment?
   d. Be guided by the most common usage in courses in biology with special consideration of college-preparatory material?
5. In our study should we follow the arrangement of the textbook or the laboratory material? Which should come first, the text assignment or the laboratory work and observation?
6. In our organization of the course should we
   a. Follow up the evolutionary plan so as to proceed from the simple to the complex even if this requires that we use prepared and preserved materials or those bought from biological supply houses?
   b. Select the material in the local environment when it is abundant for the major part of our study in class?
   c. Let the students bring to class the materials for study?
7. In our organization of the course should we
   a. Repeat the organism to illustrate different processes or repeat the study of the process or principle in the study of each organism?
   b. Which of these is likely to result in the more use of living organisms for study?
   c. Which is the more natural type of organization of the course?
   d. Which is more saving of teacher's time in getting materials for study?
8. Should the chief emphasis be upon training students for college entrance and the advanced courses in botany, zoology, and physiology, or should the emphasis be placed upon interesting the student in a study of living things and solving problems important to them?
9. Should the major part of the material for study come from the great out-door laboratory or an improvised laboratory inside?
10. Should biology be organized under separate units of study as:
    a. Classification or Taxonomy
    b. Form or Morphology
    c. Function or Physiology
    d. Habitat or Ecology?
    Or is it possible to include all of these under a unified study of living things based on the seasonal plan?
11. Is there any necessary and important part of elementary biology that cannot be well taught in the seasonal arrangement? Does it tend to confuse the student? Is it scientific?
12. Is it possible to arrange a good course in biology during the regular school year that begins in the first of September and closes in the last of May? Will all essential life processes be illustrated?
13. If we arrange the course around the seasons, will the course be unified and organized, or disorganized and broken into small bits?
14. Will the study of biology based on the seasonal plan develop lasting interests in students which will continue after the course is completed, such as,
    a. The destructiveness or benefits of insects?
    b. The coloration of leaves?
    c. The fall of leaves?
    d. Storage of food by plants?
    e. Careful selection of food in the diet?
    f. Health preservation?
    g. The migration of birds?
    h. The spawning of fish; egg-laying of other animals?
    i. The blossoming of flowers, trees, shrubs?
    j. An interest in heredity, especially in man, and the improvement of the race?
    k. The enjoyment and conservation of things?
15. Considering all other types of organization, is the seasonal plan the best?

SOME GUIDING PRINCIPLES FOR A COURSE IN SEASONAL BIOLOGY

1. The course should be a series of problems which the student feels are in need of solution.
2. The problems should be interesting and therefore within the student's own experiences.
3. The problems should have a definite value culturally or economically, and this value should be stressed in the problem.
4. The problems may consist of experimental work, careful observations, checking of data, and confirmation of results by references.
5. The problems should be so arranged that the knowledge gained in one problem will be of use in the solution of the next.

6. The arrangement of the problems should be continuous and consecutive so that each individual problem will be a part of a greater problem or understanding toward which the entire course leads.
7. The beginning of each problem should be as nearly as possible in its natural setting or life-situation which will furnish the need.
8. The solution of each problem should have some definite contribution to an understanding of life as it exists in the great outdoors or in modern life and conditions under which man works and lives.
9. There is too much useful work to crowd into a course in biology that busy work need never be introduced.
10. The incentive for the solution of many problems may be the desire to know how the organism lives and carries on its work or life-processes, so that we may work with the Laws of Nature rather than in ignorance of them.
11. As far as possible the dominant interest of the student for the particular time of year should be considered so that not the incidental but "the purposeful plan of seasonal changes" which are taking place in all living things may form the framework on which the course is built.
12. By following the seasonal plan, the use of living things will be increased while the use of specimens dried or preserved will seldom be necessary.
13. If the course is held together and organized around natural conditions and the life as it exists, an artificial plan for holding the course together will not be necessary.
14. Living things brought to the laboratory or studied in the field will be a necessary, rather than an incidental, part of the course.
15. If the environment is not present for the solution of the particular problem, some other problem should be substituted in its place.
16. Only by experiences does the student learn and so biology should offer an opportunity to study and interpret the activities of living things in their own environment.
17. "How does the organism solve its life-problems?" is the chief point of emphasis rather than an artificial set-up in which life processes are illustrated by the use of organisms.
18. The emphasis should be on function rather than form, on physiology rather than anatomy, on how the organism lives and reproduces rather than on classification and technicalities.
19. Emphasis should be placed on those living processes which are common to all organisms, on interrelationships and the interdependence of organisms.
20. The student should be led to appreciate and to desire to conserve living things, to improve his own health and that of others, to increase his own and others' happiness and knowledge of nature.
21. The seasonal plan might be briefly explained as an attempt to organize biology around the dominant form of life and dominant interest in life at the particular season.

In the fall, we have noted the destruction of insects, or their great service. We note the coloration and fall of leaves. We study the foods the plants have stored in the seeds naturally. We are interested in this food for the body. How is it digested, carried to parts of the body, used by the body? How do we maintain health in the winter? The little organisms that cause diseases interest us, and then we begin our search for higher forms of life. As spring approaches, we become interested in the first birds that appear, the flowers, the fish, frogs, reptiles, and mammals. At last, we are interested in man's heredity and close our study with eugenics or the improvement of the race. Biological principles are studied in relation to each organism rather than trying to study organisms in relation to principles.

SUMMARY OF COURSE IN BIOLOGY ORGANIZED ON THE SEASONAL BASIS

1st General Problem: The need of food is common to all living things.

Introductory statement—Man gets his food from many sources, plant and animal. We have both friends and enemies in our food problem.

1. Some common insects are both friends and foes of our food problem.
   - The grasshopper—often enemy number one. How it eats, lives.
   - The larvae of butterflies and moths are usually enemies although the adults may be friends of our food supply.
   - Beetles and bugs often destroy, but some of them help our food supply.
   - The honey bee makes food and carries pollen for our good.
   - Biting and sucking insects must be controlled differently.
   - The housefly and mosquito are pests and enemies of our health.
   - How to control certain insect pests such as cockroaches, termites, flies, mosquitoes, grasshoppers, bugs, clothes moths.
2. The world's supply of food is dependent on plants for manufacture.
   - Photosynthesis—need of chlorophyll, sunlight, CO_2, H_2O, leaf cell.
   - Structure of typical leaf—how adapted to food making.
   - Some common leaves—types, coloration, identification of plants.
   - Storage of food by plants in seed, root, stem, leaf, bulb, tuber.

The bean, a typical dicot seed—protein, starch—tests for each.
The corn—a typical monocot seed—starch, oil—location, tests.
The plant seedling uses some of its own food for growth.

3. The selection of a proper diet is important to the health of man.
   Carbohydrate foods—starch and sugars. Tests for, use to body, sources.
   Protein food—plant and animal sources, tests, complete and incomplete.
   Fat food—tests for—plant and animal sources, use to body.
   Minerals—sources, kinds needed, uses to body.
   Vitamins—diseases resulting from deficiencies, foods containing.
   Bulk in diet—cellulose, vegetable and fruit sources, use to body.
   Food requirement in calories—balanced diet, acid and base forming food.
4. Food must be digested before it can be assimilated.
   Mouth digestion—teeth, saliva, ptyalin, glucose from starch.
   Stomach digestion—pepsin, rennin, hydrochloric acid, peptones.
   Intestinal digestion—bile, pancreatic juice, intestinal juice.
   The large intestine as a storehouse of waste, absorption of water.
   Enzymes, food acted on, effect, organ of body, glands, secretions.
5. Food must be absorbed and carried to the blood stream.
   The small intestines are particularly suited for absorption, villi.
   Path of carbohydrates, proteins, fats to circulation.
   The liver as a storehouse of glycogen.
   The lacteals and lymphatic system.
   The capillaries and blood vessels, path to circulation.
6. The circulatory system acts as a carrier of food and oxygen to the cells.
   The systemic circulation—heart, arteries, veins, capillaries.
   Pulmonary circulation—lungs, red blood corpuscles, hemoglobin.
   Portal circulation—path of foods to and from liver, wastes.
   Lymphatic circulation—plasma, lymph, body cells fed and wastes removed.
   White blood corpuscles or leucocytes, also called phagocytes.
7. The respiratory system supplies the oxygen and carries off the waste carbon dioxide.
   Our air-conditioner—the nose, trachea, bronchi, alveoli.
   The lungs are specially fitted for taking in oxygen, remove CO_2.
   How we breathe—ribs, diaphragm, pleura.
   Diseases affecting the respiratory tract. Cause, prevention, cure.
8. Waste materials from food metabolism must be eliminated from body.
   The skin—perspiration, body temperature regulator, protection.
   The kidneys—protein wastes, urea.
   The liver—urea, worn-out red blood corpuscles.
   The spleen—also red-blood corpuscles carried away.
9. Our body is built out of the food we eat—assimilation, metabolism.
   The skeleton and muscles—framework held together and moved. Posture.
   The central nervous system—brain, spinal cord, nerves.
   Autonomic system — sympathetic nerve centers.
   Special senses—sight, hearing, touch. taste, smell.

2nd General Problem: All living things must reproduce if they survive. How the species is maintained. Heredity.

1. Simple plants are both interesting and important.
   The compound microscope opens to us a new world.
   Simple Algae—Pleurococcus, Spirogyra, Diatoms—live and reproduce.
   The yeast and bread mold are typical fungi—budding, spores.
   Bacteria are simple plants—shapes, reproduction, food.
   Cultures of bacteria exposed to various places.
   Disinfectants, germicides, preservatives are variously effective.
2. Simple animals differ in many ways from plants.
   Protozoa in the hay—infusion—Vorticella, Paramecium.
   Special cultures—Amoeba. How they live, reproduce.
   Water—supply must consider small organisms.
   Sewage—disposal is dependent on small organisms.
3 The health of man is dependent on small organisms.
   Diseases caused by bacteria—toxins, antitoxins, vaccination.
   Other diseases are caused by protozoans and filterable viruses.
   Internal parasites—worms may cause much trouble for man and beast.
   Immunity—community health, quarantine.
4. Higher plants have more complex forms of reproduction.
   The moss plant is a simple example of alternation of generations.
   The fern plant shows definite advances in

methods of reproduction. The pine family illustrates the naked seeds. Flowering plants belong to the seed group inclosed in an ovule. Pollination is carried out in different ways—wind, insects, water. Fertilization is necessary. Mitosis and moiosis. Some common families of plants. Study of flowers. Fruit blossoms and tree flowers as they bloom. Home beautification by use of flowers, shrubs, trees.

5. Higher animals differ from plants in many ways.
   The Metazoa—hydra, sponge, earthworm, crayfish. Increasing complexity. The fish—vertebrate, spawning, gills for breathing, bodily structure. The frog—amphibian, egg-laying, gills change to lungs. The reptiles—snakes are both poisonous and harmless, even beneficial. Birds—migration, mating, singing, colors, nesting, identification. Mammals—reproduction, classification. Economic importance.
6. Some common characteristics of all life.
   Evolution—gradual increase in complexity. Classification from simple to complex. Heredity—Mendel's laws. Eugenics—the improvement of the heredity of man. Conservation of all resources.

AN EXPERIMENTAL STUDY TO COMPARE THE LABORATORY METHOD OF INSTRUCTION WITH INDIVIDUAL DEMONSTRATION IN ELEMENTARY COLLEGE BIOLOGY *

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Editor's Note: The report on this study, though received a year ago, is significant in pointing out another angle of approach to the moot question of the method of experimental work in science. Many more studies are needed to arrive at a scientific answer to the question. What we need to know most is more about the nature of learning in science and thus our question will receive a more basic answer.

The prevailing procedure in teaching elementary college biology today is the individual laboratory method. Yet numerous studies [1] reveal its many inadequacies. Among these are lack of economy of time and material, and comparatively poor results in imparting essential knowledges. In addition, the laboratory period is often misused. Hunter [2] cites the following:

1. Prevalence of copying and duplication in the laboratory.

2. "Fixing" laboratory work in order to fit the requirements of the laboratory guide.

3. Burying the object of the experiment under a voluminous mass of laboratory directions.

As a result some authorities [3] offer the Teacher-Demonstration method as an effective substitute, thereby disregarding the superiority of the laboratory method in the development of motor skills, attitudes and interests. Most workers [4] agree, though,

* Based upon an unpublished thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Education in The School of Education, The College of the City of New York, 1937.

[1] Downing, Elliot R. "A Comparison of the Lecture Demonstration and the Laboratory Methods of Instruction in Science." *School Review* 33: 688–697; November, 1925.

[2] Hunter, George W. *Science Teaching at the Junior and Senior High School Levels.* New York: American Book Co., 1934, pp. 172–173.

[3] Schlesinger, H. I. "Important Criteria in Evaluating Laboratory Work." *Education* 56: 393–396; March, 1936.

[4] Buckam, W. B. "An Endeavor to Contact Objectives with Method in the Teaching of Science." *School Science and Mathematics* 36: 610–614; June, 1936.

that the best possible use of the demonstration method is in conjunction with the laboratory method. It seems clear that if one is time-and-effort consuming, use of both would be even more so.

These difficulties prompted the writer to seek a means whereby he could combine the advantages and at the same time not include all the limitations of both procedures. This was found in the practicum, a testing device at present. The technique of the practicum was revised and adapted for use as a teaching method. The resulting procedure, a hybrid containing elements of the demonstration and laboratory methods, is called by the writer "Individual Demonstration."

INDIVIDUAL DEMONSTRATION

Contained in the elementary biology syllabus are many units which lend themselves easily to division into a series of related topics, each of which may be presented in the form of a demonstration. The subject matter of the entire unit may be covered in this way. It is entirely possible, then, that a student who applies himself to a study of these demonstrations would master each unit. Here we have the crux of the new method.

First, a suitable unit was found, namely, "The Liverwort, Marchantis." It was divided into related topics (habitat of the plant, asexual reproduction, sexual reproduction, and life cycle), each of which was then demonstrated by use of slides, models, diagrams, living or preserved specimens, or charts. For example, asexual reproductiontion of Marchantia was shown microscopically by means of a slide of a cross-section through a cupule. A series of 20 such demonstrations, placed singly on student laboratory tables, was sufficient to cover the entire unit adequately.

The next step consisted in providing students with a means whereby they might master the entire unit. Obviously, mere observation is insufficient. Guidance is essential. This was provided by permitting students to use either laboratory guides or the text in studying the demonstrations. Further, a series of cards accompanied the demonstrations. For example, the card beside the demonstration of asexual reproduction reads as follows:

9. Reproduction may be either sexual or asexual. The asexual is illustrated here.
   a. On what surface are these cup-shaped structures found?
   b. What are they called?
   c. Note the structures found within. What are they called?
   d. Of how many cells is each of c. constructed?

Note the clue contained in the introductory sentences. The answers to these questions were obtained: (1) directly, by observation of the demonstration (e.g., questions 9a and d), (2) by use of the laboratory guide (e.g., questions 9c and b), and (3) with the aid of the text. When the answers were determined, they were written on a specially prepared mimeographed answer sheet in the spaces provided for them. Since this card was at table 9, the answers were placed in the ninth box. It seems evident from the foregoing, that these answers may be made to serve the purpose of a test or as a basis for review.

To enable each of the twenty students to see all the demonstrations, an individual was allowed only a limited time at a table, namely, about 3 minutes. At a given signal, all moved to the next higher-numbered table, where a new demonstration was studied. Slightly over 60 minutes was required for a complete round of the tables.

This method has been criticized because it fails to provide for individual manipulation of materials. It should be understood, however, that the individual demonstration is a demonstration procedure, set forth for use in elementary college biology, mainly a descriptive course at the College of the City of New York at the time of the study. Majors in biology, who need practice in dissection, receive such training in advanced courses. The new method substitutes the advantage of time-saving, guided

instruction on teacher-prepared demonstrations. Also, the writer offers this as another technique of teaching biology, not as one which will completely supplant the others.

The unit of work employed in this study was chosen for several reasons. Firstly, it is adaptable for presentation by the new method; secondly, it is a representative unit of college biology; and finally, it is especially convenient. The writer believes that most units in the college biology syllabus could have been used to serve the purpose of this study.

THE PROBLEM

The object of this study was fivefold:

1. Fundamentally, the writer attempted to compare the relative effectiveness of the individual demonstration and the individual laboratory methods with respect to the acquisition and retention of factual information.
2. Secondly, this study was concerned with the way in which the individual demonstration could be combined with the laboratory method so that most behefit might be derived from the limited period of laboratory work. The experiment with one class, Class I, was designed to measure the value of the new method as an introduction to laboratory work. With another class, Class III, the writer aimed to discover its value for review purposes. (See Table I.)
3. Since the new method may be conducted in the same manner as an examination, the writer claims that it is a period of intense concentration and is highly motivated. Results obtained should, therefore, be very good. To ascertain whether or not this is true was another aim of this study.
4. To determine whether any particular group profited more from the individual demonstration, the writer compared the achievements of the following categories, including both the control and experimental groups:
   a. High intelligence (4th quarter) students.
   b. Low intelligence (1st quarter) students.
   c. Non-science students.
   d. Science students.
5. Finally an attempt was made to determine which method provided more effectively for certain general objectives of science teaching, such as scientific attitude, observation, and appreciation of science.

METHOD

To secure objective data on these questions, an "equivalent-groups" experiment was conducted. The subjects of this study were four laboratory classes (each class consisting of two sections, each section of twenty students and one instructor) divided evenly into experimental and control groups. These met once per week for four hours, three of which were devoted to laboratory work, and the remaining one hour to a recitation on it. The experimental groups (except Class II) were subjected to the new method for a period of one hour, and spent the rest of the time studying the same unit in the same way as the control groups. One experimental group, Class II, learned the material by means of the individual demonstration alone, while all the controls experienced only the individual laboratory method. Before the start of the recitation, a final objective test (F.T.) was given each group to measure the immediate effects. Several weeks later, a second test (D.R.T.) was applied to measure delayed retention of subject matter. Along with the tests, the experimental groups were required to answer and return a questionnaire.

It has been noted that the main problem of the experiment was divided into several sub-problems. An attempt was made in this study to solve each of these. Table I provides a summary of the procedure used with respect to the various classes.

It was impressed upon three of the classes that the new method was a learning procedure, not a test. The questions on the cards were to be answered merely for the purpose of learning the unit. On the other hand, the students of the fourth class (Class IV), were told that the demonstration methed was a device for testing as well as for learning, and that they would be marked on the responses to the questions.

EQUATION OF GROUPS

In conducting an experiment of this type, it is essential that both groups be equated with respect to the trait measured, namely, ability to profit from laboratory work. The experimental and control

TABLE I

SCHEMATIC REPRESENTATION OF THE PROCEDURE USED WITH RESPECT TO THE FOUR EXPERIMENTAL GROUPS, AND COMPARISON WITH THAT OF THE CONTROLS

Class	Group	First Laboratory Period				Lapse of Time	2nd Lab. Pd.
		1st Hour	2nd Hour	3rd Hour	4th Hour		1st Hour
I	A	Ind. Demon.	Ind. Lab.	Ind. Lab. & F.T.	Recitation	2 Weeks	D.R.T. Quest.
II	A	Ind. Demon.	Ind. Demon.	F.T. Quest.	Recitation	1 Week	D.R.T.
III	A	Ind. Lab.	Ind. Lab.	Ind. Demon. & F.T.	Recitation	1 Week	Quest. D.R.T.
IV	A	Ind. Lab.	Ind. Lab.	Ind. Demon. & F.T.	Recitation	1 Week	Quest. & D.R.T.
I–IV	B	Ind. Lab.	Ind. Lab.	Ind. Lab. & F.T.	Recitation	1 or 2 Weeks	D.R.T.

Where—
Group A refers to the Experimental Group,
Group B to the Control Group,
F.T. to the immediate retention test,
D.R.T. to the delayed retention test, and
Quest. to the questionnaire.

groups of each class were therefore equated on the basis of:

1. Intelligence—percentile ranks on the Thurstone Psychological Examination were used.
2. Laboratory grades—a practical examination has been given each of the classes before the experimental factor was administered. The grades on this examination were used for equation.
3. Degree sought—e.g., science or non-science.
4. College class—e.g., freshmen.

Table II provides a summary of the equation of the groups on these bases. Note that the Critical Ratio of the difference in intelligence was computed in order to show whether it was statistically significant. Since the ratio was sufficiently low (decidedly below 3), the writer assumed that the two groups were equivalent with respect to this trait.

Since, according to object 4 of this study, the high and low intelligence and the science and non-science groups were tested for the relative effects of the experimental factor, they were equated as follows:

1. Low intelligence (1st Quarter) students of the experimental and control groups differed only by 2.3 points (S.D. 7.1 and 8.5, respectively) in intelligence and by .5 (S.D. 11.2 and 10.1) in laboratory grade. Since neither of these differences was significant statistically, the groups were assumed to be equivalent.

2. High intelligence experimental and control groups differed by .4 (S.D. 3.7 and 1.9) in intelligence and 5 (S.D. 7.84 and 8.1) in laboratory grade. No significance was shown by either.

3. Science and non-science groups were equated only on the basis of laboratory grades. For the science students a mean difference of .8 point (S.D. 10.08 and 17.86) was shown. A difference of .2 point (S.D. 13.75 and 12.08) was found in the non-science group. Neither of these was statistically significant.

FINAL TESTS

Owing to the fact that this study tested immediate as well as delayed recall of factual matter, two forms of final test were constructed. They were made up of 25 short-answer type questions of three kinds, fill-in multiple choice, and matching. The items were factual in nature and include:

1. Names of parts (structure).
2. Habits of the plant (ecology).
3. Interpretation of structure in terms of function.
4. Classification.
5. Methods of reproduction and life cycle.

TABLE II

EQUATION OF THE GROUPS ON THE BASIS OF INTELLIGENCE, LABORATORY GRADE, DEGREE SOUGHT, AND PRESENT COLLEGE CLASS

Class	Group	No. Cases	Intelligence			Lab. Grades		Degree Sought		Present College Class			
			Mn.	S.D.	C.R.	Mn.	S.D.	Sci.	Non-Sc.	Fresh.	Soph.	Jr.	Sr.
I	Exptl.	15	83	12.6		63	8.2	8	7	0	9	6	0
	Contl.	15	81	14		66.5	9	10	5	1	12	2	0
II	Exptl.	13	67.6	22.6		62.9	9.94	7	6	0	10	3	0
	Contl.	16	67	22.7		63	11.1	9	7	0	12	4	0
III	Exptl.	12	76.2	15.6		72.5	8.4	6	6	0	1	11	0
	Contl.	11	78	16		77.1	8.5	6	6	0	0	11	1
IV	Exptl.	15	Data unavailable			54.5	14.9	6	9	Data unavailable			
	Contl.	17				52.6	14.4	7	10				
I–IV	Exptl.	55	73.2	24	.6	63.2	13	27	28	0	20	20	0
	Contl.	60	70.8	21.2		63.7	14.9	32	28	1	24	17	1

Where—
Mn. is the mean
S.D. the Standard Deviation
C.R. is the Critical Ratio

In order to determine whether the tests measured what they were supposed to measure, the writer was compelled to use indirect means. He authoritatively determined the validity of the tests by asking several instructors whether they judged them to be good ones. The responses being in the affirmative, the writer speculatively analyzed the tests. He believed that they thoroughly measured all subject matter that should have been learned as a result of the work in the laboratory.

The reliability of both forms was determined in two ways. First, each of two special groups was given its own form two weeks in succession.* The Spearman coefficients of correlation were as follows:

For the first group, first trial with the second, rho (F.T.) = .70 ± .0623

For the second group, first trial with the second, rho (D.R.T.) = .78 ± .0408

The coefficients thus derived were not accurate because of the practice and study effects. Therefore, a second method (split-half) was applied. The coefficients (Spearman) obtained for the whole of each form were:

rho (F.T.) = .49 ± .094
rho (D.R.T.) = .41 ± .101

Since the groups were comparatively homogeneous, these coefficients may be considered reliable.

The questionnaire administered to the experimental groups consisted of 10 questions subdivided into 40 items. Answers to the questions were mostly of the "Yes-No" type. In general, it sought to determine whether the new method:

1. Was interesting in comparison to the individual laboratory method.
2. Served as an effective review when presented during the last hour of the laboratory period.
3. Exerted any unfavorable influence due to the testing aspect contained in it.
4. Provided for outcomes other than those sponsored by the laboratory method.
5. Was deficient in promoting outcomes for which the laboratory method provided.
6. Could displace the laboratory method entirely.

* A fifth class, divided into 2 groups, was used to determine the reliability of the two forms.

TREATMENT OF DATA

After all the grades on the final tests were computed it was necessary to treat them statistically. The assumption was therefore made that we were dealing with a normal group or a representative sampling.

Central Tendency and Variability. The measures calculated included the mean, and the standard deviation. Any difference in the average scores of the control and experimental groups was assumed to be due to the experimental factor (Individual Demonstration).

Reliability. It is a well-known fact that, even though two methods are equally effective, in general, a difference, due to chance, would almost invariably be found in a single experiment of this kind. To show that the difference obtained was larger than could reasonably be accounted for by chance the standard error of the mean difference was calculated.

The usual formulae for the $\sigma_{diff.}$ are not valid for use in this experiment because the groups were matched.

Therefore the formulae used in this study were:

(a) For large samples (at least 30 cases)

$$\sigma_{diff.} = \frac{\sigma_{M\ diff.}}{\sqrt{N}}$$ [1]

Where $\sigma_{M\ diff.}$ is the standard deviation of the mean of the differences in the scores of the paired individuals. From this, the Critical Ratio was computed according to the formula:

$$\text{C.R.} = \frac{M_{diff.}}{\sigma_{diff.}}$$ [2]

A critical ratio of 3 or over is sufficient to be significant.

(b) For small samples (less than 30 cases) Fisher's formula was used. It involved the calculation of "t," which is comparable to C.R.

$$t = \frac{M_{diff.}}{\sigma_{dist.}\sqrt{\frac{N_1 + N_2}{N_1\ N_2}}}$$ [3]

Where $\sigma_{dist.}$ is the Standard Error of the distribution and is calculated according to the following formula:

$$\sigma_{dist.} = \sqrt{\frac{\Sigma D_1^2 + \Sigma D_2^2}{N_1 + N_2 - 2}}$$ [4]

where ΣD_1^2 is the sum of the squares of the deviations of the scores from one mean.

To determine the significance of the obtained value of "t," it was necessary to consult Fisher's tables,* which are corrected for the number of cases used. The fewer the cases, the larger must be the value of "t"' in order that it might be significant or highly significant. (Fisher gives two values, one for significance, the other for very great significance.)

RESULTS

A careful study of the data presented in Table III will show that the following results were obtained in this study:

1. Where the new method was used for introductory survey purposes, i.e., Class I, the experimental group showed a gain over the controls of 10.4 points on the F.T. (immediate recall test) and of .6 point on the D.R.T. (delayed recall test). Since the results on the first were significant, while those on the second were not, the indication was that there was little of lasting value to be gained from the use of the new method in this way.

2. Exclusive use of the Individual Demonstration by the experimental group of Class II resulted in a gain over the controls of 1.8 points (not significant) on the

[1] Peters, C. C., and Voorhis. *Statistical Procedures and Their Mathematical Bases,* 1935. p. 195.

[2] *Op. cit.,* p. 195.

* Such a table may be found in J. P. Guilford's *Psychometric Methods,* 1936, Table K, Appendix, p. 548.

[3, 4] Snedecor, George W. *Calculation and Interpretation of Variance and Covariance,* 1934, p. 17.

TABLE III

RESULTS OF ALL FOUR CLASSES ON THE IMMEDIATE RECALL TEST AND THE DELAYED RECALL TEST

Class	Test	Group	No. Cases	M	S.D.	Gr. Fav. $M_{diff.}$	t	Fisher's Constants: Sig.	Fisher's Constants: Highly Sig.	$\sigma_{diff.}$	C.R.
I	F.T.	Expt.	15	65.2	13.4	Expt.	2.31	2.048	2.763		
		Contl.	15	54.8	9.3	10.4					
	D.R.T.	Expt.	14	56.6	11.3	Expt.	.15	2.052	2.771		
		Contl.	15	56.0	9.0	.6					
II	F.T.	Expt.	13	63.5	14.2	Expt.	.3	2.052	2.771		
		Contl.	16	61.7	14.6	1.8					
	D.R.T.	Expt.	10	76.6	7.8	Expt.	4.4	2.093	2.861		
		Contl.	11	56.7	11.4	19.9					
III	F.T.	Expt.	12	63.5	19.3	Expt.	3.17	2.074	2.819		
		Contl.	12	41.0	11.6	22.5					
	D.R.T.	Expt.	12	64	17.1	Expt.	2.18	2.074	2.819		
		Contl.	12	50.8	9.5	13.2					
IV	F.T.	Expt.	15	50.8	16.8	Expt.	2.33	2.042	2.75		
		Contl.	17	42.6	4.1	8.2					
	D.R.T.	Expt.	14	53.7	12.8	Expt.	.97	2.045	2.756		
		Contl.	17	49.2	11.6	4.5					
I–IV	F.T.	Expt.	55	59.8	16.7	Expt.	3.05	2.0		1.36	6.1
		Contl.	60	51.4	12.7	8.4					
	D.R.T.	Expt.	52	61.5	15.8	Expt.	2.85	2.0		1.5	5.1
		Contl.	59	53.8	12.4	7.7					

Where—
F.T. refers to the Immediate Recall Test.
Gr.Fav. is the group favored by the results.

immediate recall test. The extremely large difference (19.9 points) obtained on the D.R.T. is probably due to the fact that the instructor of the experimental section, unaware that a second test was to be given, conducted a recitation on Marchantia immediately before the delayed recall test was administered. This was not done by the instructor for the control group.

3. With one class (Class III) using the new method for review purposes, a mean difference was obtained of 22.5 points on the F.T. and one of 13.2 points on the D.R.T., both significantly in favor of the experimental group. Note that this was the only one of the four classes that achieved such a result.

4. The other class using the new method for review purposes (Class IV) was told, in addition, that the Individual Demonstration was a test. The results obtained showed a difference in favor of the experimental group of 8.2 (statistically significant) on the F.T. and of 4.5 (not significant) on the D.R.T.

5. It was found that the experimental group of the composite class (made up of students of the four classes) gained 8.4 points on the immediate recall test and 7.7 points on the delayed recall test. Both these differences in means were significant.

Note that the significance of the results of the individual classes was determined by the Fisher method because of the small

number of cases. On the other hand, where the classes were combined, the Critical Ratio was computed.

Table IV is a review of the findings with regard to the special groups.

1. It was found that students of lower intelligence gained significantly over similar controls. On the immediate retention test, the first quartile bettered by 13.8 points the mean of the controls, and by 22.5 points that on the delayed recall test. The fourth quartile students (superior intelligence) showed no significant results.

2. Science students gained 15.2 points on the immediate recall test and 25 points on the delayed recall test by use of the new method. Both gains were significant. Non-science students gained 3 and 2.9 points on the F.T. and D.R.T., respectively, with the introduction of the new method. Neither gain was significant, however.

The questionnaire was given to a total of 65 students from the experimental groups, of which 40 returned them. The number and types of responses were tabulated. Considerable agreement with regard to views on certain questions indicated that students were convinced of the following:

1. The new method was interesting both alone and compared with the laboratory method.

2. It served as an effective review of the day's work. (See results with respect to Class III.)

3. It strengthened weak points in the students' knowledge of the unit.

4. Use of the individual demonstration as a test seemed to have an unfavorable aspect. The discrepancy in the findings of Class IV with those of Class III bore this out.

5. The new method was placed most favorably at the end of the laboratory period. (See Class III.)

6. The consensus was that the new method cannot entirely replace the Individual Laboratory method.

7. Class II, which was taught the unit solely by means of the new method, believed that the material was learned thoroughly, and at least as

TABLE IV

COMPARISON OF THE FIRST WITH THE FOURTH QUARTILES (INTELLIGENCE) AND THE SCIENCE WITH THE NON-SCIENCE STUDENTS ON THE FINAL TESTS

Test	Stud. Group	Group	No. Cases	M	S.D.	Gr. Fav. $M_{diff.}$	t	Fisher's Constants	
								Sig	Highly Sig.
F.T.	1st Quart.	Expt. Contl.	10 10	63.8 49.0	14.17 13.74	Expt. 14.8	2.405	2.093	2.878
	4th Quart.	Expt. Contl.	10 10	65.0 62.6	12.4 9.9	Expt. 2.5	.48	2.093	2.878
D.R.T.	1st Quart.	Expt. Contl.	8 10	70.5 40.8	17.2 13.7	Expt. 22.5	2.912	2.12	2.921
	4th Quart.	Expt. Contl.	10 10	62.4 66.8	11.7 12.1	4.4 Contl.	.8	2.093	2.878
F.T.	Science	Expt. Contl.	27 32	69.0 53.8	14.6 15.93	Expt. 15.2	3.55	2.0	2.66
	Non-Science	Expt. Contl.	28 28	51.5 48.5	16.29 11.33	Expt. 3.0	.76	2.0	2.667
D.R.T.	Science	Expt. Contl.	26 32	75.1 55.0	16.28 14.96	Expt. 20.1	4.8	2.0	2.665
	Non-Science	Expt. Contl.	26 28	55.4 52.5	16.77 8.3	Expt. 2.9	.87	2.0	2.668

well as it would have been learned under the laboratory method.

8. Dissection, manipulation of material, detail and explanation, and provision for use of the scientific method are essential components of the laboratory method which were not present in the new method. However, the first two were not considered essential for the student who did not major in biology.

9. The individual demonstration was rated better with respect to two criteria, namely, the development of desirable study habits and development of the powers of observation and reasoning.

CONCLUSIONS AND RECOMMENDATIONS

After a review of the results of the experiment, the writer concludes that, under the conditions of the experiment,

1. Use of the individual demonstration resulted in a large increase in the amount of subject matter learned and retained as compared with use of the individual laboratory method alone.

2. The best use of the individual demonstration was in conjunction with the laboratory method.

3. It was best placed at the end of a period with a specific unit of work. This use was essentially for review purposes.

4. Students who are working for a science degree and those of relatively low intelligence were most favored by introduction of the individual demonstration.

It is recommended therefore,

1. That more research on the merits of the new method be undertaken.

2. That such research undertake to determine whether any other units are favored by the new method.

3. That such research, to be more adequate, should involve the use of a large group which would be subjected to the individual demonstration throughout an entire course.

4. That, unless subsequent research proves otherwise, the following constructive steps might well be undertaken in the reorganization of the method of teaching elementary college biology:

a. That the new method be introduced into the college system of biology teaching.

b. That elementary biology classes be then divided according to the degree sought by the students.

c. That science students be subjected to the new method.

d. That the new method be used in conjunction with the individual laboratory method and for review purposes.

Editorials and Educational News

N. A. R. S. T. MEETS AT CLEVELAND

By vote of the membership it has been decided to hold the annual February Meeting of the National Association for Research in Science Teaching at Cleveland, Ohio, rather than at San Francisco in conjunction with the American Association of School Administrators. It is hoped that many teachers of science and other educators in the Central states will avail themselves of the opportunity to be in attendance at what appears to be a very challenging program.

FIFTEENTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

CLEVELAND, OHIO

FEBRUARY 15, 16, 17, 1942

Sunday Evening, February 15, 1942

Hotel Allerton

C. P. Cahoon, *Presiding*

6:30 P. M.

Dinner meeting, members only.
Presidential address.
Business meeting.

Monday, February 16, 1942

Morning Session

Hotel Allerton

C. P. Cahoon, *Presiding*

9:30 *Business meeting.*

10:00–10:35 *Review of Significant Studies in Science Teaching that Have Been Reported during the Past Two Years.*
Nathan A. Neal, James Ford Rhodes High School, Cleveland, Ohio.

10:40–11:15 *Science Implications of the Eight Year Study of the Progressive Education Association and of the Cooperative Study in General Education.*

11:20–11:55 *Report of the Science Committee, Department of Science, National Education Association.*
Ira Davis, Chairman of the Committee, University of Wisconsin.

Discussion: A five minute period for discussion will follow each number.

P. M.

12:15 *Luncheon*—at convenience of members.

Afternoon Session

Hotel Allerton

C. P. Cahoon, *Presiding*

2:00–2:50 *What Is Science?*
Mathew Luckiesh, Director Lighting Research Laboratory, General Electric Company, Nela Park, Cleveland.

2:55–3:40 *Science as Applied to Industry.*
O. F. Carpenter, Associate District Representative of the Office of Production Management, Training within Industry, District 13, State of Michigan and Lucus County, Ohio.

Discussion: A five minute period for discussion will follow each number.

Evening Session

Hotel Allerton

Ellis C. Persing, *Presiding*

6:30 Informal dinner meeting and program planned by Cleveland teachers.

Tuesday, February 17, 1942

Morning Session

Assembly Room, Cleveland Clinic

Florence Billig, *Presiding*

9:30–10:15 *Teaching Human Development in the Science Program.*
Robert J. Havighurst, Secretary, Committee on Human Development, The University of Chicago.

10:15–11:35 *Report of Studies Relating to Organs in Human Beings and Other Animals that Affect Intelligence, Power, and Personality.*
Dr. George Crile, Director, Cleveland Clinic.
Dr. Quirling, Associate in Research, Cleveland Clinic.

10:35–12:00 Visit Museum, Cleveland Clinic Foundation, to see illustrations of the results of the extensive studies carried on by Dr. Crile and Dr. Quirling.

P. M.

12:15 *Luncheon*—at convenience of members.

Afternoon Session

Trips to places in Cleveland of interest to science teachers. Arranged by Committee on arrangements.

Ellis C. Persing, *Chairman*

N. C. E. S. MEETS WITH N. A. R. S. T.

The National Council on Elementary Science will meet with the National Association for Research in Science Teaching at Cleveland on February 16 and 17 by action of the Executive Committee of N. C. E. S. Advice to this effect has been received just before going to press.

THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

Various investigations by committees and individuals on phases of the teaching of the basic sciences in schools and colleges throughout the country have led to a recognition that many of the problems cannot be solved except by cooperative effort of all concerned. Consequently, several informal meetings of interested people have been initiated by Professor K. Lark-Horovitz, of Purdue University. These meetings have been attended by mathematicians, physicists, chemists, biologists, and educationists. In April, 1941, the Cooperative Committee on Science Teaching was created by representatives of several scientific societies. Robert J. Havighurst, of the University of Chicago, was elected Chairman. Glen W. Warner, Wilson Junior College, Chicago, was named Secretary.

The Need for a Cooperative Committee. There is need for cooperation among groups of scientists, teachers of all the basic sciences, educational experts, and school administrators on problems which no one group can solve working alone. Many of these problems deal with science in the secondary school, such as, licensing or certification of science teachers for high schools, the training of science teachers, and correlation of the sciences in the high-school curriculum.

Membership. The Committee consists of the following:

Representing *The American Association of Physics Teachers*
K. Lark-Horovitz, Purdue University.
Glen W. Warner, Wilson Junior College, Chicago.

Representing *The American Chemical Society*
B. S. Hopkins, University of Illinois.
Martin V. McGill, Lorain High School, Lorain, Ohio.

Representing *The Mathematical Association of America*
A. A. Bennett, Brown University.
Raleigh Schorling, University of Michigan.

Representing *The Union of Biological Societies*
Oscar Riddle, Department of Genetics, Carnegie Institution of Washington.

Representing *The National Association for Research in Science Teaching*
G. P. Cahoon, The Ohio State University.
Robert J. Havighurst, The University of Chicago.

Relation of the Committee to Parent Organizations. The Committee will have an advisory relation to its parent organizations. It will report to them regularly through their representatives. Its recommendations will be released for publication in the various scientific and educational journals with the aim of securing comment and criticism by members of the sponsor organizations.

AGENDA OF THE COMMITTEE

Licensing or Certification of Secondary-School Science Teachers. This problem, with its associated problem of combinations of subjects to be taught by the beginning teacher

in the small high school, is generally recognized as a serious one. Most teachers begin their work in small high schools of two hundred or fewer students. In such high schools a teacher must teach three or four different subjects. Therefore, a college graduate with highly specialized training in a single science is at a disadvantage in securing a position or in his teaching if he is appointed. The Committee hopes to formulate a policy to which all the scientific societies can agree and which suits the realities of the teaching situations. The Committee hopes to make this study so thorough and its reommendations so practical that its report can be used by certification authorities as a basis for action.

The College Training of Prospective Science Teachers. The Committee recognizes the difficulty of preparing science teachers for such broad teaching assignments as are given to most new teachers. This problem will require careful study with the aim of planning a program which will secure the necessary breadth of science training, give adequate opportunity for specializing in one science, and provide for professional courses in education as well as a sufficient number of courses for general culture.

Exploratory Studies of the Secondary-School Science Curriculum through Workshops and Conferences. The Committee hopes to stimulate the science departments of a number of colleges and universities to bring secondary-school teachers to their campuses for cooperative work on their educational problems. Out of workshops and conferences held at colleges and universities would probably come plans for improved science courses. These activities would provide good in-service training for science teachers and would enable the secondary-school teachers to make their problems and their points of view evident to the college scientists.

Problems of State or Local Agencies Needing the Services of Educational Consultants on Questions Pertaining to Science Teaching. The Committee offers its services as a consultant to state or local agencies working on problems pertaining to science teaching. The Committee may thus provide direct connection between such agencies and the societies represented on the Committee. For example, the Committee might become associated in a curriculum study in some state, cooperating with the state department of education and the college and secondary-school science teachers of that state. The results of such a project might prove valuable to other states.

Meetings. Meetings have been held in Chicago, April 19, 1941, and November 22, 1941.

FOR THE SEVENTEENTH TIME

That Science Teacher Scout, Hanor A. Webb, has given us another excellent list of books under the title, "The High School Science Library for 1940–41," in the November issue of *Peabody Journal of Education.* This annual list is the latest in the series which began in 1925–26. While no mention of reprints accompanies the bibliography, we trust that the author will provide reprints at the low cost made on the lists of previous years.

The usual cumulative price groups are indicated for the titles. The range of the reference books is from the grades to junior college level. High school textbooks in science are given in a separate section of the bibliography. A very brief annotation accompanies each title.

May we express to the author the appreciation of our readers and ourselves for the service which he has contributed and is contributing through this time-consuming, but interesting we trust, activity.

SCIENCE CAN HELP

Attention is called here to the brief article by Pressey appearing in this issue. It contains a series of excellent suggestions regarding areas of education for defense in which science teachers at all school and junior college levels may contribute scientific understanding and conscious techniques of scientific procedure in intelligent choice of action during the emergency.

It is hoped that our readers will send us other articles dealing with the potentialities of science for instruction in defense and particularly dealing with experiences, activities, and "units" which they have found to yield desirable outcomes in this area.

In this connection, the national interest being shown in nutrition education should challenge science teachers. The National Nutrition Conference was held last October to discuss nutrition education as an integral part of the school program. Science teachers will look forward to the future plans and reports of the group. We are prompted to wonder if the science teachers and supervisors have been invited to contribute to the group. We are also

prompted to invite science teachers in the elementary school as well as general science and biology teachers to send us statements concerning their activities in this field.

A word of challenge seems in order here. If science teachers allow others to take over safety education, conservation education, health education, nutrition education, consumer education, recreation, and the many other significant functional aspects of science, they will be left in the position of teaching the traditional, academic subject which contributes only indirectly or incidentally to living in this period of emergency and in the period of restoration and reorganization to follow.

GOING DEEPER FOR SCIENTIFIC DATA

Only yesterday we were scientifically startled by announcements of the production of the electron microscope with its unusual resolving power. Now, while greater and greater resolutions are attempted through improvements, comes the interesting story of three dimensional, or stereoscopic, micrographs produced by a new photographic technique.

Members of the American Association for the Advancement of Science, meeting in annual session at Dallas, Texas, heard the new technique described by Drs. Zworykin and Hillier of the R.C.A. Laboratories. It will be recalled that these two men were among the first in America to contribute to the development of the electron microscope, Dr. Zworykin at the R.C.A. Laboratories and Dr. Hillier, with others, at Toronto University.

From a recent release by the R.C.A. Manufacturing Company, Inc., at Camden, New Jersey, we quote certain excerpts describing the new technique, its revelations and some of its potential applications.

> With this new method, the scientists reported, the electron microscope, which recently made it possible to photograph the influenza virus for the first time, becomes a more powerful tool for use in science and industry.
>
> Since development of the electron microscope for commercial use little more than a year ago by R.C.A. scientists have been looking at tiny objects that lie far beyond the range of the light microscope. But these objects, many of them magnified as much as 100,000 times, have been seen in a flat plane only. Now, with the new technique, substantially more information as to over-all size and shape can be obtained.
>
> Scientific investigation in such fields as biology, bacteriology, medicine, chemistry, ceramics, and metallurgy are expected to benefit greatly from the improved observation. Information as to the size and shape of infinitesimally small objects, it is pointed out, leads to new knowledge of their distribution and behavior. The knowledge, in turn, provides the basis for the development by science and industry of new and useful practices, services, and products.
>
> The electron microscope is especially well-suited to the preparation of three-dimensional pictures, Zworykin and Hillier said, because of its remarkable depth of focus. Two pictures of the object are taken in succession, the object in a special holder being tilted through a fixed small angle with respect to the instrument's axis, first in one direction and then in the opposite. When the two pictures so obtained are placed in an ordinary stereoscope, the object, greatly magnified, appears in its proper space relationship.
>
> Aided to some extent by the new stereoscope technique, Drs. A. Glenn Richards, Jr., of the University of Pennsylvania, and Thomas F. Anderson, R.C.A. Fellow of the National Research Council, are making special studies of insects with the electron microscope. Results of this research were reported to the Association in another joint paper.
>
> A factor contributing to the success of this research was the development for the first time of a technique for cutting sections (slices) of solid material sufficiently thin for study in the electron microscope. (0.1 micron or four millionths of an inch thick.)
>
> A study of electron micrographs of insect structures of cockroach and mosquito larvae was made to throw light on how insects breathe (obtain oxygen) through their skin and how certain insecticides kill insects by coming in contact with their skin.
>
> Cockroach skin was found to be made up of many layers, including a thin outer layer of continuous water-repellent material, a thicker continuous layer, and a thick layer of laminated material through which passed tiny pore canels having a helical shape. These canals averaged about 0.15 microns (6 millionths of an inch) in diameter. While theory had previously indicated the probable existance of these canals, their presence is thus confirmed for the first time with the aid of the electron microscope. A single cockroach has about two billion of these canals.
>
> Mosquito larvae skin is very thin—about one twenty-five thousandths of an inch thick—and is continuous, consisting of a very thin outer layer

and a thicker inner layer. Since both cockroach and mosquito skin have layers with no holes in them, it is concluded that air and possibly other substances must diffuse through these solid layers.

Another way in which insects obtain oxygen is through a branching system of thin walled tubes called tracheæ which communicate with most parts of the body. These tubes somewhat resemble the bronchial tubes of the human anatomy.

In presenting their findings on insects, the two scientists showed electron micrographs of insect tracheæ, butterfly scales, and beetle elytra to illustrate the minute anatomical details to be found in insect materials. They said that details reach magnitudes of the order of one millionth of a centimeter or less (4 ten millionths of an inch). Included among the micrographs were stereoscopic pictures illustrating three-dimensional relationships in insect tracheæ.

The electron microscope, perfected in the R.C.A. Laboratories, as the result of discoveries made in the development of the R.C.A. all-electronic system of television, has been in practical use for about a year. Capable of magnifications up to 100,000 diameters because of its high degree of resolution, the intrument has opened whole new worlds of scientific investigation and industrial application.

During 1941, the R.C.A. Manufacturing Company built and installed sixteen electron microscopes for various scientific institutions of the country, including the United States Bureau of Standards, Universities and industrial laboratories. The instruments are being installed only where they will have direct usefulness in national defense.

NEEDED EDUCATIONAL RESEARCH

In the December, 1941, issue of the *Phi Delta Kappan* which is devoted to Research in Education, the reader will find, in addition to some excellent articles on the structure, trends and reporting of educational research, an excellent bibliography on problems suggested for investigation and a challenging list of topics needing immediate research. The issue also contains a list of references of practical value to the research worker.

While few items in the bibliographies and list refer specifically to science education, a number of them will suggest to the research worker, teacher, and supervisor in this field many problems in line with trends in American Education.

EDUCATION IN 1941–1942

Large numbers are always challenging to many persons. School officers and teachers like to know they are engaged in a great enterprise. Here are some large approximate numbers from the United States Office of Education:

Elementary pupils	20,707,000
Four-year high school pupils	7,334,000
First grade entrants	2,090,000
Kindergarten pupils	665,000
Elementary school teachers	700,000
High-school teachers	350,000
High-school graduates	1,275,000
Higher Education students	1,450,000
College graduates	175,000
College freshmen	400,000
Graduate students	100,000
Master's degrees granted	25,000
Doctor's degrees granted	3,200
Instructors in higher education	110,000

THE HIGH SCHOOL GRADUATE

United States Commissioner of Education Studebaker, writing in the December issue of *School Life,* on the need of more education in economics on the part of our secondary-school pupils gives the following picture of the present-day graduate of our high schools:

> The average person graduating from high school receives 3 or 4 years of instruction in English, including literature and composition; 2½ or 3 years of the social studies, usually 1 year of United States history, 1 year of European history, ancient or modern, and 1 year of economics or sociology or civics. He has studied algebra for 1 year and plane geometry for another. He has taken 2 years of natural science, including an elementary course in general science and another in physics, and he has had 2 years of a foreign language, either ancient or modern. Now I have mentioned 12 of the 15 units required for graduation. The rest of his work has been distributed among elective subjects in the same fields just mentioned, except that if he departed from the average course, he may have had 1 year of industrial arts work and 1 year of typewriting, bookkeeping, or some other commercial subject. Having completed such a course in high school, he will have taken the subjects required for admission to college where, in all probability, he will continue for 2 additional years to pursue similar subjects before beginning a specialization in some one field.

Obviously the reference above to "another (year) of physics" is given as an

example but does not apply to the average graduate. A very small percentage of the graduates, probably not more than six per cent, pursue a course in physics. Moreover, statistics for the country at large do not appear to support the statement that the graduate has taken two years of science. Of course, it is clear that the statement is meant to give only an approximate picture. Those of us interested in seeing that science is adequately represented in the courses pursued by graduates of the secondary school would be somewhat cheered by a figure of two units in science. Unfortunately for us the figure is probably about 30 per cent above reality.

A HANDBOOK FOR PRE-SERVICE TEACHERS

Emphasizing first-hand experiences for students being inducted into the teaching profession, this handbook represents the joint efforts of a group of students from the School of Education of the University of Wisconsin, the Director of Laboratory Activities in the basic education courses required of all prospective teachers at that institution and her graduate assistant. The Director is Camilla M. Low.

The handbook describes, in one hundred twenty pages, the place of laboratory experiences in the program for teachers, the laboratory opportunities in the schools of Madison, the laboratory opportunities in the social agencies of Madison, ways of studying the pupil through the activities, techniques and findings in the study of the community background of the pupils, essentials of group leadership, and many practical and concrete suggestions for participants in the program.

The philosophy of education underlying the handbook and the nature of activities engaged in by the perspective teachers highly commend the publication. Here is a report largely concerned with the actual experiences, voluntary and required, of student-teachers. It will serve newcomers in student-teaching with a wealth of assistance. Teachers of science, "critic" teachers, and those offering courses for science teachers will gain much by careful examination of the monograph.

JUNIOR COLLEGES

The country's abnormal situation caused by defense activities has not affected enrollment in the nation's 650 junior colleges as severely as had been expected, according to a study just completed by Walter C. Eells, executive secretary of the American Association of Junior Colleges.

The study reveals that enrollments in public junior colleges show an average drop of only 10 per cent from those of last year, while in private junior colleges there has been a slight increase of less than one per cent. The change in public junior colleges may be explained by the fact that they are for the most part coeducational and therefore affected by the decrease in the enrollment of men, whereas many private junior colleges are women's colleges.

Of the public institutions, only 29 reported an increase, 19 no change, and 139 a decrease. Replies ranged from an increase of 40 per cent to a decrease of the same amount. Of the private institutions, 73 reported an increase, 56 no change, and 71 a decrease. Replies ranged from an increase of 60 per cent to a decrease of 50 per cent.

Several institutions which have evening as well as day work report a falling off in the full-time day enrollment but that this is more than made up by the marked increase in evening enrollment on the part of young men now employed in defense industries during the day.

An interesting change in emphasis of studies preferred by students is also seen in the replies. Technical, scientific, and short business courses are in great demand. One administrator comments: "We notice a pronounced swing from the so-called cultural subjects to the scientific and vocational."

In New York, junior colleges report an average decrease in enrollment of eight per cent. Of 12 institutions which furnished data, one reported an increase, three no change, and eight a decrease.

DEFENSE PAMPHLETS AVAILABLE

The U. S. Office of Education is publishing a new series of approximately twenty pamphlets under the new general title, Education and National Defense, designed to assist educators in contributing toward the promotion of understanding and the encouragement of effective citizenship. Six of these are now available, at fifteen cents each, from the Superintendent of Documents.

No. 4. *What the Schools Can Do*
No. 9. *Home Nursing Courses in High Schools*
No. 13. *Hemisphere Solidarity*
No. 15. *Education Under Dictatorships and in Democracies*
No. 17. *How Libraries May Serve*
No. 22. *Food for Thought: The School's Responsibility in Nutrition Education*
No. 23. *Democracy in the Summer Camp*

Teachers of science in elementary schools and high schools, as well as camp directors, will find helpful suggestion, activities, and source materials in the various pamphlets.

Abstracts

SECONDARY SCIENCES

MICHAUD, HOWARD H. "Importance of Field Work for the High School Biology Teacher." *The American Biology Teacher* 3:205–208; March, 1941.

There is no means of fully evaluating the importance of field work to the teacher in the secondary schools. The gains derived will lead not only to greater recognition but will enhance the success of the teacher in the cassroom. Those who do not possess this background are usually not teaching biology with the enthusiasm of the leaders of science. Field work and outdoor guidance offer one of the most valuable means of motivating both the teacher and the students. Several concrete examples of field trips are included.

—C.M.P.

FITZPATRICK, FREDERICK L. "The Training of Biology Teachers: Data from a Questionnaire." *The American Biology Teacher* 3:253–260; May, 1941.

This is a report upon the formal training of secondary school biology teachers, based on data obtained in 1940, from 3,186 biology teachers. Of the 3,186 teachers, 1,685 had baccalaureate degrees only, 1,311 the M. A. or M. S. degree, and 48 a doctorate. Of this group 1.533 had majored in biology in college and 933 designated biology as a minor. Somewhat less than a third had no special training to teach biology. The average number of college credits in biological science was 37.1 semester hours. The teachers want more subject matter courses of a functional type. Special methods courses need to be improved. There should be improved training in laboratory and demonstration techniques, more functional observation and practice teaching and training in techniques especially adapted to schools having little equipment and material.

—C.M.P.

MEISTER, MORRIS. "Demonstrations to Explain Ideas." *The Science Classroom* 20:1, 4; 1, 4; 1, 4; April, May, and June, 1941.

An important element in the art of teaching science is the ability to arrange simple and familiar materials so that they help pupils to understand new ideas. These three issues of *The Science Classroom* include demonstration experiments as follows: (1) "A B C of the Electric Motor" by Emmanuel Kalish, (2) "Diffusion, Osmosis, and Solution" by Frederick P. Hill, (3) "Dynamo—Motor Relationship" by Daniel Brandon, (4) "A Portable Gas Generator" by Andrew Goldreich, (5) "Some Things Burn Slowly, Producing Heat Without Light" by Frederick P. Hill, (6) "An Operating Trip Hammer and Circuit Breaker" by Andrew Goldreich, (7) "Technique for Making Film Strips and Slides by Reversal Process" by Charles I. Hellman, (8) "Window Shade Charts" by Daniel Brandon, (9) "Demonstrating the Pressure Change in Cloud Formation" by Nathaniel Roth, (10) "A Pile Driver in the Classroom" by John Jablonski, (11) "Parallelogram of Forces" by A. Spector and L. Cranberg, (12) "Radiation from Different Sources" by Loring E. Typon, (13) "Audible Acceleration" by Paul I. Kaye and (14) "Archimedes Principle" by A. L. Feldman.

—C.M.P.

SHARPE, PHILIP B. "Scientific Belief, Attitude, and Skill." *The Science Teacher* 8:26–27; 35; 40; February, 1941.

A scientist believes in (1) cause and effect, (2) natural law, (3) application, (4) method, (5) free will, (6) freedom, and (7) devotion. A scientist is (1) interested, (2) careful, (3) honest, (4) open minded, (5) skeptical, (6) optimistic, and (7) brave.

—C.M.P.

LONG, ERNESTINE M. J. "Elements and Safeguards of Scientific Thinking." *Journal of Chemical Education* 18:92–94; February, 1941.

The writer briefly discusses some of the elements of scientific thinking, using specific examples to illustrate her point. General ways of thinking include the following: (1) drawing inferences, (2) analyzing situations, (3) making selections, (4) making associations, and (5) generalization. The elements and safeguards of scientific thinking are the same both for inductive and deductive thinking; only the sequences are changed. Emphasis on scientific thinking means less emphasis on teacher activity and more emphasis on pupil activity.

—C.M.P.

GOLDSTEIN, PHILIP. "The 'Practical' Test." *The American Biology Teacher* 3:234–236; April, 1941.

This paper reports a study made by the author to determine what students really "see" when using a microscope. Five microscopes with prepared slides were set up and students were asked individually to answer certain written

questions based on their observations. Results were both surprising and highly gratifying. Students like this kind of test, it can be made really diagnostic, and is a fine teaching device. This form of test measures how consistently a student has done his work, and can measure objectively the student's ability to observe, his reasoning power, and his understanding of scientific method, far more adequately than any written test —C.M.P.

CARLETON, ROBERT H. "Physical Science for General Education." *The Science Counselor* 7:48–50; 64; June, 1941.

This is the second part of an article showing how physical science is made to function in the Summit, New Jersey, High School. A typical physical science unit "Fire, Fuels, and Heat" is presented in detail.

—C.M.P.

CARLETON, ROBERT H. "Physical Science for General Education. Part III." *The Science Counselor* 7:81–82; 91; September, 1941.

This is a comprehensive unit test on "Fire, Fuels, and Heat." Part I of the test has questions on recall and application of specific knowledges; part II has questions on understanding and application of basic science principles; and Part III has questions on understanding and applications of scientific methods and attitudes. —C.M.P.

WINOKUR, MORRIS. "Scientific Method and Learning in Science." *The Teaching Biologist* 10:131–133; May, 1941.

Learning in science as portrayed by eminent scientists is not always of the inductive type—from the particular to generalization. Often the scientific method employs deductive reasoning as exemplified in the work of Einstein and Gibbs. —C.M.P.

SYMPOSIUM. "Techniques." *The Teaching Biologist* 10:58–69; January, 1941.

The suggested teaching techniques in biology found in this issue were written and planned by the Techniques Committee of the New York Association of Biology Teachers. They include: (1) cell studies, (2) reproduction, (3) evolution and heredity, (4) behavior, (5) the term calendar, (6) bibliography, (7) slides of insects and insect parts, and (8) suggested lesson plans.

—C.M.P.

SYMPOSIUM. "Supervision." *The Teaching Biologist* 10:89–101; March, 1941.

Each article presents what the supervisor expects to find in different types of lessons in one unit of instruction. The units are as follows: (1) "A Demonstration Lesson: Cells" by Lloyd A. Rider, (2) "A Socialized Recitation: Deveolpment of the Cell Theory" by Frieda B. Winner, (3) "Laboratory Work in the Cell Studies" by Estella R. Steiner, (4) "A Phase of the Work Involving Testing" by Elias Blechman, and (5) "Meeting Individual Differences" by Dorothy Blondel.

—C.M.P.

SINNOTT, EDMUND W. "Buildings, Equipment, and Textbooks Used by Teachers of Biology in Secondary Schools: Data from a Questionnaire." *The American Biology Teacher* 3:261–266; May, 1941.

Findings reported in this study were based on same data reported in the Fitzpatrick report—from 3,186 biology teachers. Equipment and conditions for work are not as satisfactory as they could be. Schools in small cities and towns do not have as much financial support as they should have, but have better opportunities for teaching biology. Individual teachers more often select the textbook, often by committee of biology teachers. State Boards of Education in the South usually select the textbooks used in that section. —C.M.P.

SYMPOSIUM. "Testing." *The Teaching Biologist* 10:105–120; April, 1941.

This issue of *The Teaching Biologist* has the following articles relating to some aspect of testing: (1) "Calibrating the Measuring Instrument" by Ellis L. Manning, (2) "Testing and Teaching Critical Thinking" by Richard E. Watson and E. A. Manwell, (3) "Role of Evaluation in Teaching" by Clark W. Horton, (4) Evaluation in the Teaching of Nutrition" by N. E. Bingham, and (5) Brief Bibliography on Testing. —C.M.P.

SYMPOSIUM. "Testing Issue—II." *The Teaching Biologist* 11:1–14; October, 1941.

This second issue on testing contains the following articles: (1) "A System of Uniform Testing" by Harold Nagler, (2) "Suggestions for Testing in Biology" by J. Wayne Wrightstone, and (3) "Preservation of Biological Specimens in Plastic" by Charles Tanzer.

—C.M.P.

MCKISSICK, H. R. "A Student-Conducted Science Assembly Program." *School Activities* 12:300; 332; April, 1941.

This article briefly describes a science assembly program and enumerates its values.

—C.M.P.

TRYTTEN, M. H., AND LEACH, JAMES M. "A Study of Secondary School Physics in Pennsylvania." *American Journal of Physics* 9:96–101; April, 1941.

This is a questionnaire study of a random sampling (905 schools) of Pennsylvania high schools. About 5 per cent of Pennsylvania high school students are enrolled in physics. Some of the findings and conclusions were:

(1) Physics is elective in 86 per cent of the schools, required in 6 per cent, required in ceratin courses in 8 per cent, (2) higher enrollment in physics is found in smaller schools, (3) only 4 per cent of the teachers teach physics alone, other sciences constitute best second teaching field, (4) Physics preparation shows that 44 per cent have less than 11 semester hours, 72 per cent no more than 14–16 hours, (5) Physcis in the high schools of Pennsylvania is definitely on the defensive, (6) Trend is toward a more useful course and (7) Large classes, heavy loads, and outside activities leave the teacher too little time to prepare laboratory work and effective demonstrations.

—C.M.P.

MACGOWAN, W. LEROY. "An Activity Program in Biology." *The Science Teacher* 8: 21–23; 28–29; April, 1941.

This article describes the activity program in biology in the Jacksonville, Florida, high school. Less time is being spent inside the laboratory and more outdoor activity is carried on. Each student has six individual activities to do in a month or six weeks. The biology work is definitely more functional and more individualized. —C.M.P.

HALL, CARROLL C. "Laboratory Epigrams." *The Science Teacher* 8: 14–15; 30–31; April, 1941.

This is a list of interesting laboratory "do's" and "dont's." —C.M.P.

CREWSON, WALTER S. "Field Work in Secondary School Geography." *The Journal of Geography* 40: 153–156; April, 1941.

Field work in geography may be either a low form of "busy work" or a vital educational process. To be the latter it must be carefully planned and executed, followed up with clear-cut classroom exercises. As an illustration of the latter, the article describes a field trip to Akron, Ohio, as a background for the study of the American Manufacturing Belt.

—C.M.P.

SEBASTIAN, W. R. "Science Club, Activities." *Biology Briefs* (Denoyer-Geppert and Co.) 4: 15; April, 1941.

This article briefly describes the science club activities of the Bellevue, Kentucky, High School. The membership of more than one hundred was divided into the following groups: taxidermy, modeling, research, shop, domestic science, photography, and astronomy.

—C.M.P.

ANONYMOUS. "Science Stunts." *Popular Science Monthly* 138: 196–197; May, 1941.

The following science stunts are described: (1) proving that the earth spins, (2) artificial bug walks on water, (3) model simulates radio tuning, (4) home-made hydrometer, and, (5) tube illustrates buoyancy. —C.M.P.

TEALE, EDWIN. "America's Five Favorite Hobbies." *Popular Science Monthly* 138: 98–103; May, 1941.

The following are America's favorite hobbies, indicating the number of people participating: (1) photography, 19,500,000; (2) stamps, 12,000,000; (3) music, 10,000,000; (4) models, 2,250,000, and (5) home workshop, 2,000,000. —C.M.P.

KNAUZ, MARIE. "Values of High School Science Clubs." *The Science Counselor* 7: 37–38; 59–60; June, 1941.

In this paper the author gives concrete examples to indicate the following specific values of high school science clubs: (1) produce important scientific results, (2) lead some members to a life work, (3) develop leadership, (4) make better science students, (5) develop loyalty, (6) develop cooperation, (7) develop social values, and (8) may practice and teach conservation.

—C.M.P.

WRIGHT, JACK. "More About Lantern Slides." *Camera Craft* 48: 527–532; September, 1941.

This article supplements a series of articles on lantern slide making appearing in the October, November and December issues of *Camera Craft*. This article describes two new developments in lantern slide making: (1) the new direct positive panochromatic film recently brought out by Eastman, and (2) the method of coloring slides using the Develochrome colors manufactured by the Fink Roselieve Company.

—C.M.P.

MEISTER, MORRIS. "Supplement Your Text." *The Science Classroom* 21: 1, 4; October, 1941.

The following demonstrations are included in this issue: (1) "The Density of Gases" by Meyer Levitz, (2) "Preparation of Aluminum by Electrolysis" by Joseph F. Castka, and (3) "A Simple Frictometer" by Albert Leenoff.

—C.M.P.

ANONYMOUS. "Films on the Faculty." Chicago: Bell and Howell Company, 1941. 30 p.

This excellent pamphlet has been prepared for those now using the motion picture for teaching and for those contemplating its use for that purpose. The following aspects are discussed: (1) "Training the Classroom Teacher," (2) "Choosing Films and Integrating Them with the Curriculum," (3) "Selecting Equipment," (4) "Developing News Areas of Instruction for the Motion Picture," (5) "Administering the Visual Education Program," (6) "Conclusion," and (7) "Suggested Reading List."

—C.M.P.

SCIENCE

SYMPOSIUM. "Defense." *U. S. Camera* 4:27–109; August, 1941.

This issue is given over to numerous articles and photographs relating to various aspects of the defense program of the United States.

—C.M.P.

CANNON, WALTER B. "Problems Confronting Medical Investigators." *Science* 94:171–179; August 22, 1941.

Numerous problems are indicated and a few are discussed at some length: social, economic and industrial problems relating to life and death and the ever more important problem of life processes in the increasing number of aged. Not only are there problems relating to specific diseases such as cancer, heart trouble, and so on, but increasingly important problems relating to the nervous system and the use of drugs.

—C.M.P.

CUMMINGS, CARLOS E. "How Plants Catch Animals." *Hobbies* 21:74–76; April, 1941.

Some plants just wait to catch animals, others set traps. The common pitcher plant of sphagnum bogs belongs to the former class. The tiny sundew, Venus's flytrap, and the bladderwort belong to the active class.

—C.M.P.

POTTER, C. E., "What Film for Night Shots?" *Camera Craft* 48:176–183; April, 1941.

Most camera users face the problem of what film would be best for night shots. This article describes how this information may be found out through practical experiences and answers the question specifically, naming the best films.

—C.M.P.

BOND, FRED. "Kodachrome Problems." *Camera Craft* 48:169–175, 126–132, 254–261; 286–296; March, April, May, and June, 1941.

The above series of articles have as subtitles: "Judging the Characteristics of Color," "How to Judge Light Conditions," and "Exposure Conditions." Each is illustrated and the practical advice offered should be most useful to all kodachrome users.

—C.M.P.

BROWNELL, L. W. "Nature and Wild Life." *American Photography* 35:364–368, 432–435, 502–506, 572–576; May, June, July, and August, 1941.

This series of illustrated articles on photographing nature and wild life presents some very practical advice for all persons interested in nature photography.

—C.M.P.

SHIPPEE, WILLIAM H. "Mirror Making." *Popular Science Monthly* 138:182–183; May, 1941.

This article describes the process of making a mirror and makes the suggestion that the secret of success lies in cleaning the glass properly.

—C.M.P.

MCKAY, HERBERT C. "Miniature Camera." *American Photography* 35:512–516, 379–383, 439–443, 581–585; May, June, July, and August, 1941.

This series of articles by a well-known photographer gives some excellent advice to the amateur using a miniature camera.

—C.M.P.

MORTENSEN, WILLIAM. "Make-up for Portraiture." *Camera Craft* 48:225–235, 279–285, 358–368; May, June, and July, 1941.

This series of articles have as subtitles: (1) "General Mechanics," (2) "Corrective Uses of Make Up," and (3) "Methods for Correction." Seven basic facial shapes are described and discussed in detail, with many illustrations. The seven basic facial shapes are the (1) diamond-shaped face, (2) inverted triangular face, (3) triangular face, (4) round face, (5) square face, (6) oblong face, and (7) oval face.

—C.M.P.

DAFROSE, SISTER M. "Notes on Catholic Physiographers." *The Science Counselor* 7:78–80, 88–89; September, 1941.

This paper presents brief, but useful and interesting information about famous Catholic physiographers of all time.

—C.M.P.

STUART, JESSE. "I Whipped an Enemy," *Journal of the National Education Association* 2:265–266; December, 1940.

This is the interesting, intimate story of a man who became a slave to the use of tobacco, but who finally became a free man again.

—C.M.P.

LEIGHTON, ALEXANDER AND DOROTHEA. "A Navaho Makes Soap." *Natural History* 48:19–21; June, 1941.

A series of 15 photographs depict how the Navahos make soap from the roots of the yucca plant. A series of 13 photographs details the construction of a "turkish bath."

—C.M.P.

AUCHTER, E. C. "Plant Research and Human Welfare." *Science* 93:385–391; April 25, 1941.

The degree of development of any society depends on the sufficiency of its agricultural resources and the efficiency of its farmers. Sci-

ence is mainly responsible for the development of our modern civilization and much of the development of this civilization may be attributed to scientific methods in agriculture.

—C.M.P.

DAVIS, EMILY C. "Christ Was Nearly 50." *Science News Letter* 39:234–236; April 12, 1941.

Dr. Albert T. Olmstead, noted archaeologist and historian of the University of Chicago, states that new studies of the Babylonian Calendar uphold the version in St. John's Gospel, that Jesus Christ was nearly 50 years old when He died and the crucifixion occurred on April 7, 30 A.D., and that the first Easter was April 9.

—C.M.P.

HANSON, W. T., JR. "The Evolution of Photography." *American Photography* 35:459–456; July, 1941.

In this first of a series of articles the author briefly traces the development of photography from man's first observation that light brings about certain observable changes.

—C.M.P.

LAIRD, DONALD A. "How Much Exercise Do We Need?" *Popular Science Monthly* 138: 59–61; May, 1941.

The following questions are asked, briefly discussed and answered: (1) Should sedentary workers take a heavy workout once a week? (No.) (2) Are setting-up exercises as good for adults as games? (No.) (3) Is exercise at bedtime good for sleep? (No.) (4) Is a day of shopping good exercise? (Yes.) (5) Is exercise itself a good way to reduce? (No.) (6) Will a dish of ice cream support a half-hour of sawing wood? (Yes.) (7) Has electricity increased our need for exercise? (No.) (9) Is housework a good form of exercise? (Yes.) (10) Does exercise after meals harm digestion? (No.)

—C.M.P.

HANSON, W. T., JR. "The Preparation of Photographic Emulsions." *American Photography* 35:560–566; August, 1941.

This second in a series of articles from the Kodak Research Laboratories discusses types of emulsions, methods of manufacture, combining and use. —C.M.P.

KINNEY, PAUL B. "Once in a Lifetime." *The National Geographic Magazine* 80:249–258; August, 1941.

This article describes the activities of a rare family—a family of four black bear quadruplets and their mother.

—C.M.P.

ANONYMOUS. "From Atom to Embryo." *U. S. Camera* 4:67–70; October, 1941.

This is a series of excellent and unusual science photographs by Fritz Goro. Included is the only picture of liquid helium ever made.

—C.M.P.

LEE, RUSSELL. "Pie Town, N. M." *U. S. Camera* 4:39–50, 88–89, 107; October, 1941.

This is an excellent article, supplemented with splendid photographs, that portrays life on the American Frontier—1941 version. Pie Town, New Mexico, is a frontier farming community.

—C.M.P.

Book Reviews

SCIENCE TEXTBOOKS AND MANUALS

DYER, WALTER S. *A Practical Survey of Chemistry.* New York: Henry Holt and Company, 1941. 480 p.

In the editor's preface, Malcolm S. MacLean says "It is one of the first books in the field of the physical sciences in general education which offers a sound basis to the student, who is not to become a chemist, for learning in the classroom and through reading a valid lay knowledge of the field and a layman's appreciation of it; of its importance in the daily life of all of the people all of the time. It is a fresh book; not an imitation of the long line of chemistry texts of the early nature study and natural history courses in American Education—it is the first, but by no means the final answer to the several questions raised by many institutions over the past twenty years as to the place of chemistry in general and liberal education, as to materials to be covered in an orientation and survey course with or without subsidiary laboratories." To this high purpose of chemistry in general education, the reviewer is in accord, but the text upon examination does not seem to reach the ideals claimed. The book would seem to be a general one semester survey of chemistry, in difficulty somewhat between that of secondary chemistry and first year college chemistry. No attempt is made (nor is it intended) to make the material closely integrate with other sciences. As a text, it would be suitable only in those courses offering surveys in each science. It would make a useful supplementary book for those schools offering integrated physical science survey courses. The subject matter content does not depart greatly from the textual content found in the usual secondary chemistry test. —C.M.P.

BOGERT, L. JEAN. *Fundamentals of Chemistry.* Philadelphia: W. B. Saunders Company, 1941. 528 p. $3.00.

This is the fifth edition of a book first published in 1924. The textual material has been brought up-to-date. Four new chapters have been added and material in other chapters rewritten. The method of treatment and the content itself are quite different from that commonly found in introductory college chemistry textbooks. More than half of the content is devoted to organic chemistry, quite a little of which is normally found in food chemistry and physiological chemistry textbooks. Possibly the text would be most suitable to those college students taking only one course in chemistry.

—C.M.P.

BOGERT, L. JEAN. *Laboratory Manual of Chemistry.* Philadelphia: W. B. Saunders Company, 1941. 153 p. $0.75.

This is the fourth edition of the laboratory manual to accompany the fifth edition of *Fundamentals of Chemistry* reviewed above. The questionnaire system of recording notes is introduced as a means of reducing the student's time and effort. Checking by the teacher is also greatly facilitated.

—C.M.P.

JORDAN, EDWIN O., AND BURROWS, WILLIAM. *Textbook of Bacteriology.* Philadelphia: W. B. Saunders Company, 1941. 731 p. $3.00.

This is the thirteenth edition of a text first published in 1908. The many editions attest to the popularity and extensive use of the earlier editions. This edition assures its retention of a deserved popularity. The book has long been recognized as one of the most outstanding and authoritative in the field of bacteriology. As a standard reference, this book would seem to have no superiors and few, if any equals.

—C.M.P.

MILLARD, NELLIE D., AND KING, BARRY G. *Human Anatomy and Physiology.* Philadelphia: W. B. Saunders Company, 1941. 525 p. $3.00.

This seems to be an unusually well-written textbook. Basic facts and elementary principles are splendidly illustrated by 285 most teachable illustrations. This text would serve admirably as the major text in a course in physiology and anatomy, and also as a supplementary text in biology survey courses, and as a reference in secondary biology courses. Excellent summaries and questions for discussion are found at the end of each chapter.

—C.M.P.

GUYER, MICHAEL F. *Animal Biology.* New York: Harper and Brothers, 1941. 723 p. $3.75.

This third edition, the second in four years, incorporates a number of changes that not only brings the experimental biology aspect up to date, but includes material now receiving increased emphasis in biology teaching. This includes a complete new chapter on ecology as the foundation for an intelligent program of conservation.

The author is a well-known authority in the field of zoology. This treatise, based on thirty years of teaching experience, is highly accurate, scholarly, scientifically sound, and is written in

a vivid, colorful style. The author attempts to make the material have a high degree of "pupil-appeal." There are more than 400 illustrations. Not only is this an excellent text for a course in zoology, but it also is an excellent reference for the biology survey course and the biology teacher. —C.M.P.

RAY, FRANCIS EARL. *Organic Chemistry.* Philadelphia: J. B. Lippincott Company, 1941. 706 p. $4.00.

The author believes that a much more systematic and complete treatment of organic chemistry than has been considered ample in the past is necessary if organic chemistry courses are to meet the needs of all groups of students taking the courses. The present text is an attempt to lead the student from the more elementary beginnings of the subject to the point where he can read with profit much of the current literature. It does this by emphasizing the methods of science, rather than the results. Special consideration has been given to the correlation of methods of synthesis which are used in the elucidation of properties. Students attaining a fairly adequate understanding of the material of this text will undoubtedly be well grounded in organic chemistry.

—C.M.P.

CARLSON, ANTON J., AND JOHNSON, VICTOR. *The Machinery of the Body.* Chicago: The University of Chicago Press, 1941. 620 p. $4.00.

The reviewer, an ardent admirer of the first edition of this text, believes that much improvement is to be found in this second edition. The book is based on years of experience of teaching the course to students at the University of Chicago, and since the appearance of the first edition in 1937, to the many users of the text itself, not only in the introductory biology course at the University of Chicago, but also in numerous other colleges. Many minor additions have brought the text up to date throughout and one entire new chapter, "Reproduction and Early Growth," has been added.

Splendid diagrams, illustrations, and photographs, challengingly presented textual material, written in a most readable literary style make this book either an excellent text or supplementary book for use in introductory biological survey courses.

—C.M.P.

WORTHEN, EDMUND L. *Farm Soils.* New York: John Wiley and Sons, 1941. 515 p. $2.75.

This is the third edition of a book intended primarily for courses in soil management and for farmers. This latter purpose indicates that the practical aspects of soil management have been emphasized. *Farm Soils* would serve as a most useful reference book for the conservation phases of biology and general science courses or for a general reference for high school agriculture courses. —C.M.P.

SCHUCHERT, CHARLES, AND DUNBAR, CARL O. *A Textbook of Geology. Part II. Historical Geology.* New York: John Wiley and Sons, 1941. 544 p. $4.00.

This is the fourth edition of a text, first published in 1915. This edition has been largely rewritten. The authors and publishers are to be congratulated upon the publication of the finest historical geology text yet published. The book ranks high among the best textoboks published in each of the fields of science. So interestingly and challengingly is the material presented and so vivid and readable is the style, that the reviewer read it with the avidity usually accorded only popular treatises in science. There are many splendid photographs and illustrations, the paper is of the highest quality, and the type most readable.

Not only will this book serve as a fine text in geology, but also as a supplementary book in physical science survey courses and as a most valuable reference for all science teachers—both college and secondary. —C.M.P.

PISTON, DONALD S. *Meteorology.* Philadelphia: The Blakiston Company, 1941. 233 p. $3.00.

This second edition of the book is a thorough revision of the first edition, augmented by elementary material on air mass methods and applications of air mass to weather phenomena. This book is intended as a college textbook for a semester course in weather. Numerous diagrams and photographs add much to the teachableness of the book. Attention is focused on principles and these are not cluttered up with a lot of extraneous material. —C.M.P.

COLIN, EDWARD C. *Elements of Genetics.* Philadelphia: The Blakiston Company, 1941. 386 p. $3.00.

This book is designed as a textbook for an introductory course in the elements of genetics with emphasis on the applications to man. The historical approach has been adopted and numerous historical references are included in each chapter. There is a thorough discussion of the economic importance of genetics and two rather long chapters on the heredity of human traits.

Numerous lilustrations, pertinent questions at the end of chapters, and a glossary all contribute to the teachableness of the book.

—C.M.P.

FASTEN, NATHAN. *Introduction to General Zoology.* Boston: Ginn and Company, 1941. 742 p. $3.75.

Introduction to General Zoology makes an especial attempt "to humanize the subject of zoology and to relate it to other fields of knowledge. The material has been handled in such

a manner that the student will, first, be attracted to zoology; second, see its relation to human welfare; and third, obtain a general knowledge of the animal kingdom that will serve as a basis for more advanced work." While the treatment stresses the logical development from simplicity to complexity in the animal kingdom, the author states that "A large group of zoologists are coming to the conclusion that it matters little where the introduction to the science begins. An enthusiastic teacher with the proper background and facilities can start almost anywhere and in the end accomplish the results hoped for in the general zoology course."

Introduction to General Zoology will serve not only as textbook in an introductory course in zoology, but also as an excellent supplementary reference in biology survey courses.

—C.M.P.

BAITSELL, GEORGE ALFRED. *Manual of Biology.* New York: The Macmillan Company, 1941. 449 p. $2.75.

This is the sixth edition of a text first published in 1923. The central idea throughout has been to lay an adequate foundation of biological knowledge by descriptions of the simpler types of organisms, and then to build the complete structure of knowledge by the consideration of increasingly complex types. Part II contains laboratory directions for experiments to illustrate the textual material. —C.M.P.

MAVOR, JAMES WATT. *General Biology.* New York: The Macmillan Company, 1941. 897 p. $4.00.

This revised edition presents a great many changes, not only in the rearrangement of material, but also through the addition of new material. Preceding the table of contents is a suggested schedule for a thirty weeks' course using the textual material and laboratory exercises suggested.

There are nearly 500 figures. Both the content and literary style should make an appeal to the student desiring to make a survey of the field of biology. The author seems to have attained better than the usual degree of integration and correlation between the various aspects of biology. His choice of teaching content seems to be considerably better than average. The text would seem to be not only excellently suitable for a course in general biology, but also quite desirable as a text for survey courses in biology. It would serve as an excellent reference book for either type of course and also for the secondary biology teacher.

—C.M.P.

WOODRUFF, LORANDE LOSS. *Foundations of Biology.* New York: The Macmillan Company, 1941. 773 p. $4.00.

This is the sixth edition of a text first published in 1922. This number of editions attests to the popularity and wide use of the book. In this edition new material has been added to each chapter, and the order of some of the chapters change. Quite a number of new figures have been added. The author states that "every precaution has been taken not to obscure the basic spirit of the book in its presentation of a broad survey of the fundamental principles of biology for the college student and the general reader." While there seems to be a greater emphasis upon material common to the field of zoology, the author does seem to have attained quite a desirable degree of integration and correlation with the plant sciences.

There are nearly 500 figures and the size of type and literary style make the book quite readable. While the book might not pass creditably as a highly desirable text in a biology survey course, it is a most excellent text for the type of course for which it is intended, and would make excellent reference text for the biology survey course, and for the biology teacher.

—C.M.P.

BRINKLEY, STUART R. *Principles of General Chemistry.* New York: Macmillan Company, 1941. 703 p. $4.00.

This is the third edition of a text first published in 1926. It has been revised and brought completely up to date. The text is intended to meet the requirements of a general college course for students who have had a preparatory course in chemistry. Such repetition in topics as there is presents a different and more advanced point of view, with emphasis on the interpretation and significance of scientific data. Altogether this text is a most scholarly work that provides a sound basis for scientific reasoning.

—C.M.P.

HOLMES, HARRY N. *General Chemistry.* New York: The Macmillan Company, 1941. 720 p. $3.75.

This fourth edition of a text, first published in 1921, keeps pace with the rapid changes in theory and application to industry. Structure of the atom is introduced early, and repeated frequently. A radical change in the usual treatment of metals has been introduced. Instead of the previous encyclopedic listing of metals and their properties, the emphasis and classification are based on properties and methods. There is a short chapter no "Strategic Raw Materials" which is most timely, but whose importance deserves more complete consideration.

—C.M.P.

SHERMAN, HENRY C. *Chemistry of Food and Nutrition.* New York: The Macmillan Company, 1941. 611 p. $3.25.

Some things, even some textbooks, improve with age—and with revision. This is the sixth

edition of the most popular treatise on the chemistry of food and nutrition. The reviewer used an earlier edition of *Chemistry of Food and Nutrition* as a student and, later on, as a text in his own course. Each of these intimate acquaintances were pleasant experiences. And now in this revised edition it seems to the reviewer that we have the best book of the several editions. The material has been thoroughly revised, brought up to date, documented with an exhaustive list of references at the end of each chapter. It is a book chocked full of information, excellent as a text, and a splendid supplementary reference for both biology and chemistry teachers. —C.M.P.

KIRKPATRICK, T. BRUCE, AND HUETTNER, ALFRED F. *Fundamentals of Health.* Boston: Ginn and Company, 1941. 595 p. $3.80.

This revised edition of *Fundamentals of Health* places increased emphasis on nutrition, genetics and human inheritance, nervous and emotional adjustments, and the endocrines. The subject matter is based on twenty years of teaching experience and "on the actual observation and careful analysis of college-student interests." Numerous tables, charts, photographs, and anatomical diagrams should greatly aid the student studying the text. The text will not only serve excellently as a basal text in a course in health, but also as a most useful supplementary reference in biology survey courses and as well as for the secondary biology teacher.

—C.M.P.

WILLIAMS, JESSE FEIRING. *Personal Hygiene Applied.* Philadelphia: W. B. Saunders Company, 1941. 529 p. $2.50.

This is the seventh edition of a text first published in 1922. So numerous have been the changes made that this edition is almost a completely new text. The social and practical aspects of personal hygiene have been emphasized. The book is most readable and would seem to serve most adequately for supplementary reading in biology survey courses, and secondary biology courses, or as popular reading for the layman.

—C.M.P.

BOLDUAN, CHARLES FREDERICK, AND BOLDUAN, NILS W. *Public Health and Hygiene.* Philadelphia: W. B. Saunders Company, 1941. 366 p. $3.00.

This third edition of a student's manual includes a revision of the material of earlier chapters and has added three chapters: "Changing Health Programs," "Food Poisoning," and "Disposal of Offal, Garbage, and Rubbish."

This manual constitutes a concise, accurate, readable approach to many aspects of health education. It is an excellent reference book for secondary health and biology courses. Major divisions of the treatise are: "General Introduction," "The More Important Communicable Diseases," "Important Non-communicable Diseases and Conditions," "Community Hygiene," and "Health Administration."

—C.M.P.

WHITBECK, R. H., AND FINCK, V. C. *Economic Geography.* New York: McGraw-Hill Book Company, 1941. 647 p. $3.50.

In this fourth edition of *Economic Geography*, the material has been brought statistically up to date, several chapters have been completely rewritten, and others partially rearranged and rewritten.

Part I is devoted to the United States and Canada, and Part II to the World outside of the United States and Canada. There are over 300 figures to supplement the excellently selected content. At the end of each chapter there are appropriate references. The type is readable and the quality of paper above the average. Altogether this book should serve not only as a most desirable text but also as a highly recommended supplementary reference.

—C.M.P.

SCIENCE REFERENCE BOOKS

HOLMES, HARRY N. *Out of the Test Tube.* New York: Emerson Books, Inc., 1941. 305 p. $3.00.

This is the third edition, revised and expanded, of one of the most popular books on chemistry for the layman that has appeared in recent years. This third edition attests to the wide usage of the earlier editions. *Out of the Test Tube* is an excellent supplementary book for high school and college chemistry courses, for survey courses in physical science, and for all laymen desiring a most readable account of the present status of chemistry. The book, written in a most readable style, with pertinent content, is most timely. Chemistry played a vital part in World War I and is now a most strategic science in America's defense efforts.

—C.M.P.

FISCHER, HELEN FIELD, AND HORSHBARGER, GRETCHEN. *The Flower Family Album.* Minneapolis: The University of Minnesota Press, 1941. 130 p. $2.50.

In *The Flower Family Album* are 458 portraits of flowers, vegetables, and weeds arranged in family groups and drawn to scale from actual, representative specimens. Bits of garden gossip and folk-lore are added to good, sound science in describing these plant relationships. Many fascinating facts and interesting information are

given about both familiar and not-so-well-known plants. Numerous suggestions for the flower grower and useful aids for the teacher are included.

The book is one of the finest that the reviewer has happened across, a fine book for the beginner in flower study whether as an amateur at home or as a reference for the science teacher and on the science shelf of the school library.

—C.M.P.

NEEDHAM, JAMES A. *About Ourselves.* Lancaster, Pa.: Jaques Cattell Press, 1941. 269 p. $3.00.

No field of study is more pertinent to man than the study of himself. Whence he came, his place in nature, why he behaves as he does, the effects of disease, nutrition, inheritance, social and institutional contacts are all areas in which he must establish suitable interpretations or to which he must make behavior modifications. One of the most common criticisms of the science training of persons not preparing for careers in science concerns its lack of pertinence to their personal problems of adjustment.

The above criticism cannot be leveled at Dr. Needham. In his book, *About Ourselves,* he has probed cautiously into the springs of man's being and has traced them along circuitous, underground ledges to their primary sources. In most cases he gives us a peek at the instruments upon which he bases his judgments. In every case the trail is as clear as that followed by a Boy Scout earning a merit badge in tracking. He takes the reader through the phyllogenetic development of man, skipping gracefully from rock to rock of fact in this stream of circumstantial evidence. Then the story of developing behavior based upon a more complex nervous system than that of lower forms, giving, possibly because of his long association with entomology, a larger place to instincts in the human than is generally accepted. He says, "the instinctive behavior of mankind shows the same characteristics: (as of animals previously discussed) it is inborn; fit to life's needs; blind and sometimes stupidly inadaptable; runs in necessary sequences; develops with the body; may or may not be called forth but once in a lifetime; and is of ancient origin, slow growth and ineradicable fixity." Your reviewer questions whether psychologists would concur in his description of the place of instinct in human affairs and war. The approach is a thought-provoking revival of interpretations of behavior long-since discarded by many, one that seems to over-simplify social, institutional, and political problems of contemporary humans. The factors producing war, for example, are likely more complicated than the drives produced by being 'well armed, well fed, well conditioned, and, like cockerels, spoiling for a fight. Whether or not one agrees with Dr. Needham, the point of view is presented in an interesting and well-organized manner.

In general, the simple graphic style of the book makes it fun to read and should be helpful to lay persons or students trying to get an overview of man's place in the biological world.

—M. L. Robertson.

KELLOGG, CHARLES E. *The Soils That Support Us.* New York: The Macmillan Company, 1941. 370 p. $3.50.

This is a popular book intended primarily for the layman, about soils and their relationship to people. However, the student and amateur soil scientist who desires to know something about the nature, use, and conservation of soils, but who cannot spend a great deal of time and effort for initiation into all the mysteries of soils, will appreciate this authoritative treatise. The fundamental principles of soil science are adequately presented in this most readable treatise.

Some chapter headings include: (1) "In the First Place," (2) "Life and the Soil," (3) "The Building Materials for Soils," (4) "The Parts of a Soil," (5) "The Rains Come and Go," (6) "Men Use the Soil," (7) "Plowing and Digging," (8) "When Do Soils Wear Out?" (9) "Planning the Use of the Soil," and (10) "Soil and Our Future."

—C.M.P.

ESTABROOKS, G. H. *Man, the Mechanical Misfit.* New York: The Macmillan Company, 1941. 251 p. $2.50.

The author, Professor of Psychology at Colgate University, sets forth the thesis that man is a mechanical misfit and that ultimately—in 10,000 years, more or less—the human race is doomed to destruction. In the first two chapters the author describes and elaborates chiefly from the standpoint of mechanical efficiency, upon the numerous animal experiments attempted by Nature. Man is one of these latest experiments. The next four chapters point out the mechanical defects and weaknesses of man. The author believes that man reached his ultimate degree of physical fitness about 10,000 years ago, and that he has continuously, at an ever accelerated pace been on the decline since. Natural selection is becoming less and less effective. Science keeps our weaklings alive to propagate their weakness at the expense of the human race as a whole. As a result of modern civilization both the race and the individual degenerates. Man's skeleton—the pelvis, feet, jaw and teeth show definite evidence of deterioration. His sympathetic nervous system is a curse. His body organs show the strain and are ill-adapted for the continuous struggle.

Most people will enjoy reading this book. Many will disagree with the single purposiveness he attributes to nature in working out her various designs. As many more will fail to

share his pessimism as to the ultimate fate of the human race. Yet the array of facts he has marshalled in support of his thesis will be hard to refute. —C.M.P.

WRIGHT, FORREST B. *Electricity in the Home.* New York: John Wiley and Sons, 1941. 372 p. $2.75.

The material of this second edition has been thoroughly revised both as to content and as to method. A new chapter on "Wiring Systems for the Farm and the Home" has been added. A few new and very practical jobs have also been added. The first part of the book consists of a series of practical jobs arranged in order of difficulty. Part II comprises eleven chapters of text dealing with the fundamentals of electricity. This is a handy, practical reference book for physics and general science teachers.

—C.M.P.

GREENLEAF, ALLEN R. *Chemistry for Photographers.* Boston: American Photographic Publishing Company, 1941. 177 p. $2.00.

This book is designed to import only the minimum of chemical information required by a photographer for an intelligent understanding of his work. Basic chemical principles involved in the most important photographic procedures and the methods by which these principles are applied to photographic procedures and the methods by which these principles are applied to photographic service are included. Chemical symbols, equations, and mathematics have been reduced to a minimum. Any photographer, professional or amateur, or science teacher sponsoring a photography club or teaching a photography unit will find this a most practical book. All phases of the photographic process are covered and numerous formulae are included.

—C.M.P.

MOLLER, C., AND RASMUSSEN, EBBE. *The World and the Atom.* New York: D. Van Nostrand Company, 1940. 199 p. $2.75.

This treatise describes the development of modern atomic physics from its beginnings at the end of the last century down to our own day. The treatment is mainly chronological and practically free of mathematical description. There are three divisions to the textual material: Part one is entitled "The Golden Age of the Great Discoveries" and takes us up to about 1913. The second and more technical part covering the period 1913 to 1925 is entitled "The Outworks of the Atoms Fall." Part three brings the chronological period up to date and is entitled "The Riddle of the Nuclei of the Atoms: The Epoch of the New Discoveries." Chemistry, physics and physical science teachers will find this little book a most readable, understandable account of the history and present knowledge of the structure of the atom.

—C.M.P.

EBERSON, FREDERICK. *The Microbe's Challenge.* Lancaster, Pa.: The Jaques Cattell Press, 1941. 334 p. $3.50.

In recent years there has been a well-received attempt to make the general reader cognizant of the impingement of science upon everyday living. Too, attention has been given to the attitudes and methods employed by the discoverers of the mileposts of scientific knowledge. Certain authors, such as Paul de Kruif, George Gray and others, have definitely humanized the "Men in White."

There are many approaches to the orientation of the student and lay reader to today's scientific progress. Dr. Eberson in *The Microbe's Challenge* has selected a happy one. He has chosen those occasions in the precarious balance between men and microbes in which the successful meeting of the microbes' challenge involved the difference between misery and plenty, senseless terror or reasonable understanding, sudden death or dragging life and robust health. He admits the bungling, the stupidity and the lack of vision which allows thousands to die who might have lived, but follows the counter-attack to the final victory that protects the lives of subsequent millions. He has given the descriptions of the battles rather quaint names, *e.g.,* The Great Opportunist, The Naked Gymnast, Gypsy Life, Night and Day Shift, Round Trips to Strange Parts, Ordeal by Ordure, Man-eaters.

"How successfully have we met the microbes' challenge?

"If in taking stock today, we assess the extent of our advances at their true value and see the long road that lies ahead, we need but remember that the progress of science in theory and practice depends more upon direction than speed, less upon individual gains than their consolidation. Somewhere along the line of attack existing gaps in our knowledge must be plugged by concentrating forces in places where certain acceptable theories have lacked support. At other points a change of strategy indicates that it would be much wiser to abandon such theories completely."

—M. L. Robertson.

FISHER, HARRY L. *Rubber and Its Use.* Brooklyn: The Chemical Publishing Company, 1941. 128 p. $2.25.

This book grew out of the experience of the author during his seventeen years as a research chemist in lecturing on the chemistry and technology of rubber. He was formerly research chemist with the B. F. Goodrich Company and United States Rubber Company and is now Director of Organic Research, U. S. Industrial Chemicals, Inc., and Air Reduction Company.

In this treatise rubber is discussed as to what it is, its history, source, how it is obtained and how it is manufactured into countless articles of daily use. The account is as free from

technical difficulties as possible and constitutes a most valuable treatise for high school chemistry courses or as a general source of information about rubber.

—C.M.P.

HAINES, DONAL HAMILTON. *Luck in All Weather.* New York: Farrar and Rinehart, 1941. 290 p. $2.50.

Luck in All Weather is the story of the author's adventures in hunting and fishing. Any hunter or fisherman will thoroughly enjoy this book, because an armchair sportsman in reading the book for review did! Told in an intimate, chatty, off-hand manner, one comes to feel that he is the author's comrade in his many outdoor trips. The author gives much practical advice, learned in his many years of experience. All lovers of wild life and the out-of-doors, as well as sportsmen will thoroughly enjoy this delightful book.

—C.M.P.

BAKER, T. THORNE. *Photographic Emulsion Techniques.* Boston: American Photographic Publishing Company, 1941. 263 p. $4.00.

This most comprehensive treatment traces the technical developments of emulsion making from the earliest beginnings up to the latest product, explains the basic principles, and states the reason for all chemical processes involved. Explicit, step by step directions are given for making of both positive and negative materials. The author has had a long practical experience in manufacturing emulsions and is a recognized authority in the field.

—C.M.P.

MATHEMATICS BOOKS

SMITH, P. K., SCHROEDER, H. F., AND SHIRLEY, E. M. *General Mathematics, a Course for Freshmen.* Ruston, La.: P. K. Smith, Louisiana Polytechnic Institute, 1938. 216 p.

According to the preface, "This course is designed primarily to serve the needs of the students of Commerce and the students in the Schools of Education and Arts and Sciences who offer only one year of mathematics for graduation." Further, "A purpose of this text is to continue the training given in the general mathematics course in high school by acquainting the student with a large number of mathematical topics of a practical and cultural nature."

The book does cover a wide range of topics of elementary mathematics, including algebra, the mathematics of finance, numerical trigonometry and solid geometry. However, the treatment of many of the topics is disappointing. One point of view of cultural mathematics holds that it should be treated in such a manner that the student may get the fundamental meaning of the subject, rather than merely learning a large number of isolated skills. This book, in the main, follows the latter course. For example, on page 30 we find all the rules for operating with positive and negative numbers, but the reader is left entirely in the dark as to why, "The product or quotient of two numbers with like signs is equal to a positive number." Also the authors have apparently been unable to resist including much of the stereotyped discussions and problems which have appeared in text books for generations.

Those sections of the book dealing with the mathematics of finance, numerical trigonometry and solid geometry are well written and modern. However, no attempt is made to give the fundamental meaning of geometry. The material of the text is limited to rules for measuring fairly simple solids.

—James H. Zant.

ZANT, JAMES H., AND DIAMOND, AINSLEY H. *Elementary Mathematical Concepts.* Minneapolis: Burgess Publishing Company, 1941. 125 p. $1.50.

This book is designed for a freshman survey course in mathematics for non-science students. In the foreword the authors say "the aim of the book is to present certain topics of mathematics from the historical and logical point of view. We have tried to make the material of this book historically and logically sound as well as simple enough to be grasped by beginning college students" of the non-science type.

In the opinion of the reviewer the authors have admirably succeeded in their purpose. The subject-matter is of the type and the scope that makes it a truly cultural survey course in mathematics. The approach is interesting and psychologically sound. The subject matter has seemingly been most carefully selected with the thought that it should be both functional and cultural. The course for which this text is planned would seem to do the same thing for mathematics that the survey courses do for the sciences. One wonders if secondary students were first exposed to a well-taught course of this type in place of the alegbra or geometry courses they usually take, if genuine interest in mathematics might not be created to the betterment of both the student and the cause of mathematics. More election by secondary students of algebra and geometry might result, and the consequences of such elections be less tragic than is now the case in all too many instances.

—C.M.P.

MINNICK, J. H. *Teaching Mathematics in the Secondary Schools.* New York: Prentice-Hall, Inc., 1939. 336 p. $3.00.

Probably no subject in the secondary school has undergone less change in content and

method since 1900 than has secondary mathematics. No subject is having as difficult time to maintain its place in the curriculum as is mathematics. True, there have been changes in secondary mathematics, but these changes have not been great enough or of the proper kind to halt the decline in mathematics enrollment. Better teaching of mathematics—teachers with a better understanding of the role of mathematics and the functions that mathematics could perform in the lives of boys and girls could halt the declining enrollment. This book will give the mathematics teacher a new perspective—in many cases a better method of attack. The author has had long experience as a teacher of secondary mathematics and of methods of teaching mathematics. Attention is paid to the history of mathematics in secondary schools, aims of mathematics, methods of teaching algebra, plane geometry, solid geometry, tests and mathematics clubs. Any mathematics teacher will find the book most helpful.

—C.M.P.

MILES, HENRY L. *First Year of College of Mathematics.* New York: John Wiley and Sons, 1941. 607 p. $3.00.

This is a book on freshman mathematics which has been used at the University of Illinois during the past two years with excellent results. "It is not intended for a survey course; neither is it expected to give a smattering of the first two years of college mathematics. Although it is intended to meet the demands of those curricula in which mathematics enters in a utilitarian role, the author believes that any group of college students who need the subjectmatter of college algebra, plane trigonometry, plane and solid analytic geometry can use this book to advantage." The above statement in the preface outlines the nature of the content in this new type of introductory college mathematics.

—C.M.P.

COMMISSION ON SECONDARY SCHOOL CURRICULUM. *Mathematics in General Education.* New York: D. Appleton-Century Company, 1940. 423 p. $2.75.

This is a report of the Committee on the Function of Mathematics in General Education, Commission on Secondary School Curriculum, Progressive Education Association. It does for mathematics what the earlier *Science in General Education* did for science. This book is based on extensive investigation, research, and experimentation. Not only has mathematics not been increasing in enrollment with increasing secondary school enrollment, but there has been actual decline. Thus a serious problem faces not only mathematics teachers but all persons who believe that mathematics offers great possibilities of service in the lives of boys and girls. The point of view throughout the volume is based upon the newer concepts of educational objectives. Part I outlines the underlying philosophy which guided the committee and discusses the relation of mathematics to the purposes of general education. Part II considers the major understandings growing out of mathematical experience. Part III surveys the evolution of mathematics and examines the nature of mathematics. Part IV contains one chapter on understanding the student and another on the problem of evaluation. An illustrative course unit follows the text as an appendix.

Mathematics in General Education will be used as a text for courses on the teaching of mathematics, and as a reference book for general methods or general curriculum courses. It should be a *must* book for all teachers of mathematics. It constitutes an outstanding contribution in secondary mathematics, philosophy, content, and methods.

—C.M.P.

TURNER, IVAN STEWART. *The Training of Mathematics Teachers for Secondary Schools in England and Wales and in the United States.* New York: Bureau of Publications, 1939. 231 p. $1.75.

This is the Fourteenth Yearbook of The National Council of Teachers of Mathematics. After an introductory chapter, the second chapter is devoted to defining certain principles which are fundamental to the training of mathematics teachers. Then follows a comparison of mathematics in the secondary schools of England, Wales and the United States, and the academic and professional training of mathematics teachers in these countries.

A few conclusions: (1) More mathematics is studied in England and Wales and pupils of 16 years of age are equivalent in mathematical knowledge to pupils of 18 years in the United States; (2) Secondary mathematics teachers in England and Wales are more often prepared to teach all phases of mathematics than are teachers in the United States; (3) Professional training is not obligatory in England and Wales, but in the United States minimum standards for certification have been set-up; (4) More college teachers in England and Wales have had secondary mathematics teaching experience than in the United States; and (5) In-service training facilities for mathematics teachers are far better in the United States.

—C.M.P.

COMMITTEE REPORT. *The Place of Mathematics in Secondary Education.* New York: Bureau of Publications, 1940. 253 p. $1.25.

This is the final report of the Joint Commission of the Mathematics Association of America and the National Council of Teachers of Mathematics. This Fifteenth Yearbook is the most important work in its field since the 1923 report of the Mathematical Association, "The Reorganization of Mathematics in Secondary Edu-

cation." Administrators, students of education and classroom teachers will find special interest in this volume.

Chapter heading are: (1) the role of mathematics in civilization, (2) looking at modern education and its general aims, (3) general objectives for secondary education, (4) the place of mathematics in education, (5) the mathematics curriculum, (6) one distribution and organization of the materials of instruction, grades 7–12, (7) a second curriculum, (8) the problems of retardation and acceleration, (9) mathematics in the junior college, (10) evaluation of the progress of pupils, (11) the education of teachers, (12) analysis of mathematical needs, (13) the transfer of training, and (14) terms, symbols, and abbreviations.

—C.M.P.

GENERAL BOOKS

GOODSPEED, EDGAR J. *How Came the Bible?* New York: Abingdon-Cokesbury Press, 1940. 148 p. $1.50.

This is the fascinating story of the preservation, collection, canonization, and translation of the books of the Old and New Testament and Apocrypha. The author is the famous translator of the New Testament. Science through archeological discoveries, has done much in these later years, to substantiate many of the statements in the Bible. A recently discovered ancient scroll has established the fact that New Testament Greek was colloquial rather than literary, thus motivating and making possible our modern translations. The date of the Crucifixion can now be fixed as April 7, 30 A. D.

—C.M.P.

CARCOPINO, JEROME. *Daily Life in Ancient Rome.* Translated by E. O. Lorimer. Edited by Henry T. Rowell. New Haven: Yale University Press, 1940. 342 p. $4.00.

This is a well documented and fascinating portrayal of life in Rome at the height of its power. There is nothing bearing on the science of the times. In spite of great aqueducts, the tenants . . . had to go and draw their water from the nearest fountain (p. 39). "The drainage system of the Roman house is merely a myth begotten of the complacent imagination of modern times" (p. 40). Rome was filthy both from a sanitary and a moral point of view. "Murderers, housebreakers, and footpads of every kind abounded in the city" (p. 48). "Marriage had become merely a form of legalized adultery" (p. 100). A woman had a new husband every year. —E.R.D.

SOOY, LOUISE PINKNEY AND WOODBRIDGE, VIRGINIA. *Plan Your Own Home.* Stanford University: Stanford University Press, 1940. 228 p. $2.50.

Home planners, home owners, and "home livers" will find many valuable suggestions in this book to make the home a more attractive and comfortable place in which to live. Fundamental, basic principles of home planning and decoration are presented: The book is stimulating and inspiring.

The authors have had wide experience. Both have had varied practical experience and are now teaching interior decorating in the Department of Art at the University of California at Los Angeles. —C.M.P.

BANKS, ANDREW J. *Pictorial Guide to Checkers.* Philadelpria: David McKay Company, 1940. 244 p. $2.00.

Time out for mental recreation! Checkers has long been and remains one of our most popular games—a game requiring real skill and critical thinking. Chance does not play a part in this game! You can become a better player by following the suggestions made in this book. It is written in popular style for beginners, students and experts. There are 535 photographic illustrations of instructive checker positions.

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